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1882	"	45	"	"	1889	"	234	"	"
1883	"	63	"	"	1890	"	289	"	"
1884	"	82	"	"	1891	"	325	"	"
1885	"	100	"	"	1892	"	316	"	"
1885	"	138	"	"	1893	"	317	"	"

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OUR NEW DRESS.

The new dress in which the present issue of The Electrical World appears, will, we trust, meet with the approval of our readers. Though somewhat smaller than the type from which the last volume was printed, the fonts here used approach more nearly in size those of the majority of technical papers, and will give an impression not less legible, we believe, than heretofore, and more in keeping with the size of the page. The less number of pages in an issue, while making the semi-annual volumes less unwieldy in size, will yet contain about ten per cent. more matter, thus bringing a welcome relief to the increasing press on our columns.

THE ELECTRICAL WORLD AT HOME.

In a supplement to the present issue, a profusely illustrated description of the new home of The Electrical World is presented in the belief that its readers will be interested to know something about the way a modern technical journal is conducted. Starting with humble quarters at No. 9 Murray street, it has thrice outgrown its offices and been compelled to seek new and more commodious accommodations, until finally, after years of wandering, it has returned and found an abiding place in the magnificent new Postal Telegraph Building, next door to its first home. The W. J. Johnston Company, Ltd., has now not only comfortable but elegant quarters, and possesses every facility for the disposal of its large and constantly increasing business. It may prove interesting to some of the readers of The Electrical World to follow its history, which is briefly traced in the supplement, from its birth many years ago, through the vicissitudes of its early days, down through the first years of electrical development, to its majority, into which it entered a few months ago.

COMPETITION WITH CENTRAL STATIONS.

An interesting question recently came up before the Massachusetts Board of Gas and Electric Light Commissioners, in regard to the right of the owners of an isolated electric light installation to run wires under a public highway to supply a neighboring building with current. In the specific case considered authority had been granted to the owner of a building by the Boston Board of Aldermen to lay pipes in an underground duct to supply another building with steam. When the trench was opened, in addition to the pipes for which authority had been given, another one was laid to carry electric wires, and the Board of Aldermen subsequently passed an order giving permission to use it for the purpose intended. Upon appeal to the State Board of Gas and Electric Light Commissioners, objection by a public electric lighting company to such use was sustained, on the ground that a business like that of transmitting electricity through the streets of a city must necessarily be transacted by a regulated monopoly and that free competition is impracticable. "It is clear," the opinion states, "that if isolated plants are permitted to exercise public franchises over limited areas in the city, the burden to each consumer of maintenance of the general companies will be enhanced; for such a removal of its customers, as would certainly happen by the multiplication of businesses like that conducted by the appellees in this case, would of necessity add to the cost of light to the whole community." The soundness of this argument cannot be disputed, for any general system of supply, whether of gas, water or electricity, would be impossible if through private competition the more profitable portions of territory were withdrawn. On the other hand it serves to draw attention to the great power that may be conferred by a franchise, and to the fact that a company holding such a grant has not only the character of a commercial enterprise but also that of a trustee for the public in the exercise of the powers conferred.

TWO PHASED MOTORS.

We print in full elsewhere the paper by Dr. Duncan and several of his students which was read at the Philadelphia meeting of the

American Institute of Electrical Engineers, and gives an account of experiments with a two phased motor. This forms another of the original contributions to the subject of multiphased phenomena which Dr. Duncan is in the custom of making, and demonstrates once more the great value of his contact method of obtaining alternating current curves. It will be noted that one of the conclusions of the experiments is that it is of great importance to design rotary field apparatus so that both the applied and counter E. M. F.'s shall follow the sine law. It is but a few years since a well known English electrician ridiculed the idea that there was an advantage in having alternating curves follow the sine law, but the deductions of Kennelly and these experiments both prove that the advantage is a real one and moreover of great practical importance, particularly, as shown by Dr. Duncan, in the case of large multiphased motors. It is also pointed out that self induction has a beneficial effect in damping fluctuations in the armature current, but it is not made clear whether there would be a balance of advantages to justify designing armatures with a very high self-induction. Two important points, however, in designing are brought out, relating to the conditions for securing the sine form of curve above referred to. It is shown that to satisfy these conditions projecting pole pieces for the field windings must be avoided, and the armature windings must be numerous, this latter requirement being only practically possible in larger machines. (In this connection we call attention to an abstract in the Digest of a German paper on some experiments with alternators to determine the form of their current curves and the conditions influencing the same.) The result of the experiments on larger motors, referred to at the conclusion of the paper, will be looked forward to with much interest, particularly as there has been a great lack of experimental data with which to test the various mathematical theories that have been advanced on the subject. Few of the latter, we venture to predict, will be shown to have much practical value on account of the inherent difficulties offered to such a treatment.

STORAGE BATTERY IMPOSSIBILITIES.

Occasionally we read in newspapers predictions of the possibilities of the coming storage battery, and some enthusiasts have even prophesied that when "perfected" ocean steamers will be propelled by this popularly misunderstood apparatus. While, of course, every one with an iota of electrical knowledge recognizes the absurdity of such a claim, yet an illustration of how absurd it is may be of interest, and to furnish this we will apply the necessary calculations to the case of the new Cunarder Campania. The best transatlantic time of which we have a record made by this ship, whose displacement is 18,000 tons, was 5 days, 12 hours and 15 minutes, during which the average speed was 21 knots, corresponding to about 26,000 average horse power and a consumption of coal for the trip of about 2,700 tons. Assuming storage batteries of 50 pounds to the hourly horse power, the entire weight of batteries to do the same work, and allowing for no reserve, would be 76,750 tons of 2,240 pounds, or more than four times the entire displacement of the ship. To determine the weight per horse power that a storage battery should have to compete with steam in the case under consideration, we will assume that the entire weight of the boilers and machinery of the Campania is 3,750 tons, which is probably near the actual weight. Adding the coal consumption for a trip, 2,700 tons, we have 6,450 tons as the entire weight of the electrical plant. Assuming the weight of the electrical propelling machinery to be 1,500 tons, we have finally for the total weight of the battery 4,950 tons. With these data we find that the weight of a battery, allowing for no reserve, would have to be 3.16 pounds per hourly horse power. How small this is can be appreciated from the fact that a 150-ampere hour cell would weigh on this basis only about 1¼ pounds, really about the weight of its lugs. A similar calculation would show the impossibility of storage batteries displacing locomotives, yet the writer knows of a company formed several years ago which spent several thousand dollars in attempting to perfect a battery for such a use. Much of the misconception in regard to the power of the storage battery must be ascribed to the sensational manner in which it was introduced to the public by a very great scientist, his statement in regard to holding "one million foot-pounds of energy" in his hand not yet having lost its effect. The great value of the storage battery in its proper field, which is of vast extent and as yet scarcely entered in this country, should be sufficient to satisfy its most sanguine friends. Only harm can come from making claims beyond its power to fulfil, and much harm in this way has been done, aside from the absurd instances we have here considered.

CANDLE POWER OF ALTERNATING ARC LAMPS.

In the Digest is an account of some elaborate experiments made in Germany with alternating current arc lamps, which brought out several points of much interest. It is stated that the quantity of light from an ordinary alternating arc depends upon the mean value of the current as distinguished from the square root of the mean square value. It follows that since the energy of the current is proportional to the latter, the efficiency of such an arc is greater the nearer the current curve approaches a rectangular shape. This, however, would lead to extreme inductance effects, as well as give rise, it is stated, to disagreeable noises, and the final conclusion of the experimenters is that the best ideal is a true sine curve. Another of the conclusions of the paper is that direct currents are more efficient for arc lighting than alternating currents. Taking a 450 watt (2000 c. p. nominal) arc lamp as a basis of comparison, we find that the mean spherical candle power of the same alternating lamps on three different machines was respectively 823, 907 and 970; while with the same energy and a direct current, 1292 candle power was developed with a direct current lamp. What is astonishing about these figures is the quantity of light produced from 450 watt lamps, and which, it seems, is even greater than represented, as a considerable loss in the reflector of the photometer is apparently not included. At the Philadelphia meeting of the American Institute of Electrical Engineers, several speakers, of whom one, Prof. Anthony, had made many hundred photometric measurements of arcs, concurred in upholding a statement that a 450 watt arc, enclosed by a clear glass globe, would not ordinarily give a mean spherical candle power of 500. As the absorption of the reflector of the photometer in the German experiment is stated to be 30 per cent., which is greater than that of a clear glass globe, the disparity is even greater than indicated by the candle powers in the two cases, though this amounts to 160 per cent. We cannot question the accuracy of the photometer measurements of Prof. Anthony, nor have we any reason to doubt those of the German experimenters. Neither can we ascribe the differences to lamp mechanism, or to adjustment; the latter in any case would be kept as nearly normal as possible. It would seem then that the only explanation left is that the disparity must be considered as due to differences in the carbon employed. It has long been known that the quantity of light from an arc materially depends upon the quality of carbon used, though we are not aware that any comparative experiments have ever shown anywhere as great a difference as above noted. We have been informed, however, by an arc light station superintendent of wide experience, that it is not unusual to come across carbons that will show a difference of 50 per cent. in the amount of light produced. As this is a matter of much importance to superintendents of arc stations and users of arc lights, we trust that one of our college laboratories will take advantage of the excellent opportunity it offers for investigation and experiment.

Melon Electricity.

A correspondent of an English contemporary claims, apparently seriously, that if twelve ripe melons are connected in series, with platinum wires inserted at the top and bottom, sufficient current is obtained to ring a bell. He adds that only a ripe melon gives a "strong current," and adds that cucumbers, apples, pears, carrots, etc., also give current, but not nearly as much. He makes the useless theoretical deduction that a battery of 10,000 melons will give enough current to run an electric motor of two brake h. p. We might add that if he had used copper and zinc wires instead of platinum, and had selected sour melons, the results would have been much more encouraging.

Invention of the Telegraph.

To the Editor of The Electrical World:

Sir:—Please accept my thanks for your courtesy in printing, in a recent issue, my communication. I did not intend to further trespass upon your columns, but I trust you will allow me the space in which to respond to the letter you published from Mr. Edward L. Morse.

Primarily, I desire to state emphatically that it is not the desire of the family of Alfred Vail, or of any of his friends, to claim any credit or game for his name than that to which, by all known principles of right, and fair, honest dealing, he is absolutely entitled. Neither is there any desire or intention to deprive S. F. B. Morse of the smallest degree of the credit which, to his name, is honestly and rightfully due.

Morse, in 1837, had constructed a rude wooden apparatus, by means of which he was able to record pencil marks (dots), in varying combinations (upon a moving fillet of paper), which, by laborious reference to a code or dictionary, were translated into intelligence. Previous to September, 1837, when he entered into a partnership contract with Alfred Vail, he had filed, in the Patent office, a caveat for his patent, in which, of course, were specified the features of his inventions. By the terms of the contract just mentioned it was stipulated that Alfred Vail should "devote his personal services and skill in constructing and bringing to perfection, as also in improving, the mechanical parts of said invention . . . . . without charge for such personal services to the other proprietors, and for their common benefit." He was also required to construct, at his own expense, and exhibit before a Committee of Congress, one of the telegraphs, "of the plan and invention of Morse," and assume the expense of exhibiting the apparatus and of procuring patents in the United States, and in consideration he was to receive one-fourth of all right in the invention in the United States.

An impartial investigation of the claims of Morse, as found in his caveat of 1837, will reveal the fact that not a single one of the features therein specified, and upon which rest his claims to being "the inventor" of the electric telegraph, is to be found among the constituent features of the invention as it exists to-day and identical with that apparatus as it came from the hands of Alfred Vail in 1838, and later, in 1844, in no ways changed except in slight modification of form and size.

No one who has familiarized himself with the history of the invention, during the years following the time at which Morse and Vail left New York and went to Morristown, N. J., to continue (at the Speedwell Iron Works of Judge Stephen Vail, the father of Alfred) the experiments begun in the former city, need be told whose brain and mechanical skill wrought the changes, which, in following out the conditions of his contract, devolved upon Alfred Vail, and which eliminated completely from the apparatus all of the features that constituted the basis of Morse's first caveat for a patent.

A careful reading of the terms of that contract will show that, no matter what he might contribute to the improvement and perfection of the device of Morse, it must be done "without charge and for the common benefit of the proprietors," thus debarring him absolutely from taking out in his own name any patents for the independent creations of his brain. Everything he might do must be considered as a part of the patent granted originally to S. F. B. Morse. Is it difficult to understand how Alfred Vail became a cipher in so far as any public knowledge of his part in the invention was concerned?

Had he been disposed to assert his rightful claims to recognition as the real "inventor" of all of the so-called "improved Morse telegraph," he could not have done so and conscientiously observe the terms of his contract. Had not this detergent influence prevailed, business policy would have prevented him from raising an issue as to who was the inventor while innumerable suits brought by the patentees against infringements were in the courts. Unfortunately, Alfred Vail died before the expiration of the patent and while extensive legal contests were still pending.

In my possession is a paper upon which is written in my father's own writing the following statement, showing pretty conclusively the reasons why to the name of Morse has been given the credit for the invention of the recording receiver, the sounding key and the dot and dash alphabet, when it was not he who devised them, but Alfred Vail, who was debarred by his contract from claiming publicly the credit to which he was entitled:—

"This lever and roller were invented by me, in the sixth story of the New York *Observer* office, in 1844, before we put up the telegraph line between Washington and Baltimore, *and the same has always been used in Morse's instrument.* I am the sole and only inventor of this mode of telegraph embossed writing. Professor Morse gave me no clue to it, nor did any one else, and I have not asserted publicly my right as first and sole inventor because I wished to preserve the peaceful unity of the invention, and because I could not, according to my contract with Professor Morse, have gotten a patent for it."—Alfred Vail.

Mr. Edward L. Morse cites the fact that the Supreme Court upheld Morse's claims. That is quite true, but he forgets that the suit was *not* one brought by Morse to substantiate his claims against other claims made by Alfred Vail. The suit was, "Morse and others versus O'Reilly and others," for infringement, and has no bearing whatever on the point at issue, for all of the inventions of Alfred Vail were unknown to the Court, having been absorbed, according to the contract, by the Morse patent, the one in contest.

As a matter of fact, Chief Justice Taney did not sustain all of Morse's claims, and refused to recognize the eighth claim, as specified in his patent, condemning it as untenable. Alfred Vail sought in court to obtain the justice which he knew was due him from his copartner and associate, for that supposed friend had led him to believe, as he so often expressed it: "I am confident that Professor Morse will do me justice." He passed from earth in January, 1859, thirteen years and more before the death of Morse, and the justice awarded him by Morse may be judged of by the following incident:—

On the morning of the 10th of June, 1871, Morse was the recipient of a public reception at the Academy of Music, in this city, and before an audience that thronged that edifice delivered an address upon the telegraph, lasting an hour or two. No more fitting opportunity could have been presented than then—probably his last public appearance, and, too, when his remarks were to have a world-wide circulation—for this aged man to recognize in magnanimous terms the part that his long since deceased and unhonored associate had had in the invention, the fame and honor of which he had unhesitatingly accepted as his alone.

Did he allude to Alfred Vail? He did, and in these terms: "The telegraph found a friend, an efficient friend, in Mr. Alfred Vail, of New Jersey, who, with his father, *furnished the means* to give the child a decent dress, preparatory to its visit to the seat of government." No comment is necessary. That was all this old man, standing on the brink of the grave, could say of the friend and associate to whom he was indebted for all in the electric telegraph that bore the name of "Morse."

Four weeks prior to the day of Morse's death (the following year), a member of the family of Alfred Vail sat by the side of his sick bed, and during the visit of two hours, Morse frequently said: "The one thing I want to do now, is justice to Mr. Vail."

That justice was neither rendered by him before he died, nor since by any of those whom he left behind.

New York City. STEPHEN VAIL.

The First Telegraph Station.

To the Editor of The Electrical World:

Sir:—The first telegraph station established in the world was blown down by the fierce gale of last week. It was a gigantic tree in the forks of which Morse and Smith placed their first crude apparatus for the line extending from Smith's house to the tree where Morse received the first message sent by an aerial line. The tree was used because the rustics of Cumberland County, Maine, refused to lend their barns or houses as a receiving station for a wire that in their opinion conveyed messages from the abode of the powers of darkness, and the Selectmen of the town were berated in town meeting for allowing the founders of telegraphy to stretch wires along the highway where man and beast were exposed to danger and death from lightning catchers. Men still living in the town remember a sermon preached against Morse and Smith in which they were termed impious wretches who would be eternally confounded for seeking to pry into the secret places of the Almighty. So much opposition was made to the aerial wires that underground conduits were laid, and that so skillfully, and of such good materials, that a piece which I dug up ten years ago was as good as the best made to-day, whilst the house conduits made by the same parties of tarred paper and used in several houses near by is of much better quality than several brands on the market to-day.

I happened to be in the vicinity of the tree when the gale uprooted it, and purchased it, so if any electrician would like a piece of it he can have it so long as the supply (four cords) will hold out.

New Brunswick, N. J. G. WILFRED PEARCE.

The Most Powerful Light in the World.

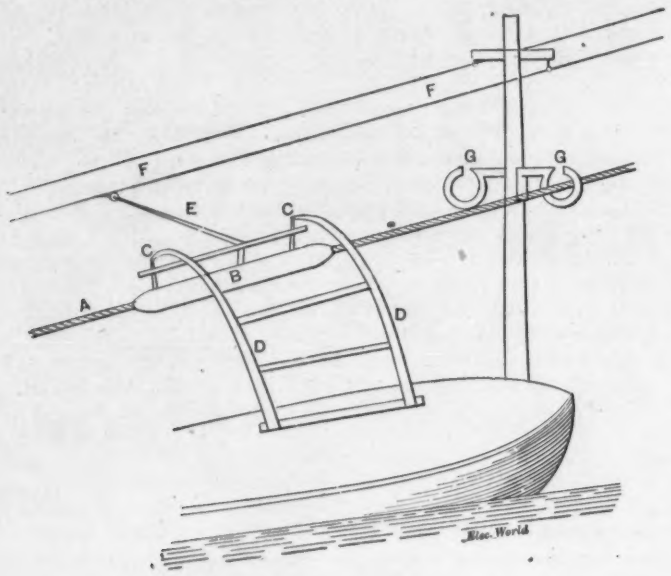
An electric light is to be placed in the Fire Island lighthouse, off New York, the candle power of which is estimated to be 450,000,000 candles.

Electricity on the Canals.

BY M. W. HASSAN.

I have been much interested in the subject of introducing electricity as the motive power on our canals, especially the Erie, in New York State, and have read all the various plans that have come under my notice, as published. The simplest one is the double trolley, using the propeller wheel in the water, the chief objection to which is the wash of the banks caused by the propeller, which would tend to weaken the banks and cause breaks. I take the liberty of enclosing a sketch of a system which is an adaptation of a telpher system, which was illustrated and described in your issue of December 20, 1890.

The poles are placed in the middle of the canal and support two working conductors and two trolley wires. The conductor and trolley wire on the right of the pole are for boats going east, and the conductor and trolley wire on the left of the pole are for boats going west. I have shown but one of the working or hauling conductors, in order not to complicate the sketch, but the other is a



Electric Canal Boat System.

duplicate of the one shown. The conductor, A, is ridged spirally or screw shaped, and the motor inside of the clyinder, B, has a cylindrical armature, which is grooved to fit the conductor, A, and, turning in one direction, propels the boat forward, and reversed propels the boat backward. The frame, C C, and stanchions, D D, support the motor, so that its weight rests upon the boat, and not upon the conductor, A. The trolley, E, completes the circuit from the conductor, A, which acts as a return from F, after the current traverses the motor. The hooks, G G, support the hauling cable, A, and have an opening sufficiently large to permit the passage of the frame, C C, and too small to allow the cable, A, to work out of its place. The hooks, G G, are insulated, and through them pass the motor. All that is necessary upon the boat is the switch, and perhaps a rheostat similar to that of a motor car. It is well for the boat to have a rudder, but it need not be used while the boat is being pulled, for the boat is guided by the cable, as the frame, C C, and cylinder, B, may be of any suitable length, even to the length of the boat, which will insure a steady pull and even purchase on the cable. The boat can also be lighted the same as a motor car, as the wire connections to the switch come down the stanchions, D D, to the boat and can be run into the light circuit also.

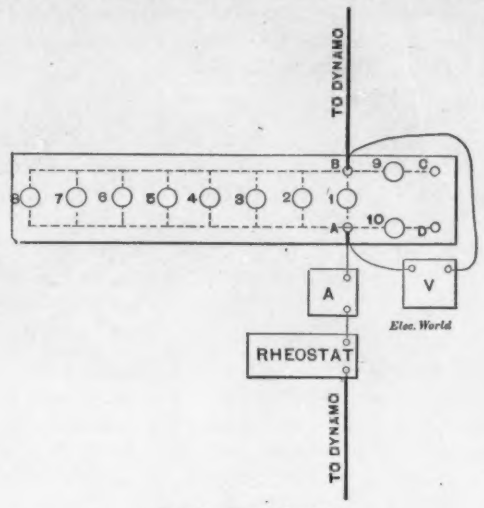
A Convenient Lamp Rheostat.

BY GEORGE A. HOADLEY.

Probably nothing is of more value to the young engineer than the ability to adapt the materials at hand to the work to be done, and there is no place where this is more called for than in an average electrical laboratory. In order to combine a lamp rheostat with a method of studying the principles of parallel and series lighting, the following lamp board was devised, and has been found of very great service. The only materials required can be found in any laboratory or lighting station, and consist of ten lamps and sockets, four binding posts, a yard of good-sized copper wire for connectors, and a base board, 6 inches wide and 30 inches long.

Believing that any instrument is better cared for and more carefully used if well made and tastefully finished, a black walnut board, 1 inch thick, was used for the base. This was carefully planed, sand papered, filled and finished with hard oil.

In the sketch, the dotted lines show the connecting wires that are



Lamp Rheostat.

fastened in grooves on the under side of the board. The binding posts are designated by letters, and the lamps by numbers.

By connecting with binding posts, A and B, a single lamp can be thrown in, or parallel circuits of from two to eight lamps can be used.

In the work done with this, the sources of E. M. F. at hand were a dynamo giving 120 volts, and storage batteries giving 40 volts. The lamps at hand were 40-volt lamps, of a resistance of 60 ohms.

By coupling, as indicated in the sketch, a rheostat and an ammeter in series with the terminals, A and B, while a voltmeter is coupled as a shunt with the same terminals, and a second voltmeter is also coupled as a shunt to the terminals of the dynamo, a most instructive study can be made of the problem of parallel distribution, including the relations between potential difference at the terminals of the dynamo, fall of potential due to the lamps, rheostat, ammeter and leads, and the parallel resistance of different numbers of lamps.

By coupling at terminals, A and C, lamps 1 and 9 can be put in series, and the essential differences between the voltages, resistances and currents used in series and parallel distribution can be very clearly demonstrated.

By coupling at the terminals, C and D, three lamps can be thrown in in series, giving the maximum resistance of 180 ohms. By throwing lamp No. 9 in series with the different parallel arrangements of the first eight lamps, a new group of resistances is introduced, and by throwing in both lamps Nos. 9 and 10, a still wider range is given.

The following table shows the possibilities when the lamps are of uniform resistance. For the sake of convenience, the arrangements are placed in the order of their resistances. Lamps of different resistances may be used, and with these the number of combinations and resistances is very greatly increased.

Arrangement.	Lamps in Circuit.	Resistance.	Current.
a.	9, 10 & q.	180.	.222
b.	9, 10 & r.	150.	.266
c.	9, 10 & s.	140.	.286
d.	9, 10 & t.	135.	.296
e.	9, 10 & u.	132.	.303
f.	9, 10 & v.	130.	.308
g.	9, 10 & w.	128.6	.311
h.	9, 10 & x.	127.5	.314
i.	9 & q.	120.	.333
j.	9 & r.	90.	.444
k.	9 & s.	80.	.500
l.	9 & t.	75.	.533
m.	9 & u.	72.	.555
n.	9 & v.	70.	.571
o.	9 & w.	68.6	.583
p.	9 & x.	67.5	.592
q.	1	60.	.666
r.	1, 2	30.	1.333
s.	1, 2, 3	20.	2.000
t.	1, 2, 3, 4	15.	2.666
u.	1, 2, 3, 4, 5	12.	3.333
v.	1, 2, 3, 4, 5, 6	10.	4.000
w.	1, 2, 3, 4, 5, 6 7	8.6	4.666
x.	1, 2, 3, 4, 5, 6, 7, 8	7.5	5.333

The fact that all changes are made by simply snapping on the lamps, makes this board a very satisfactory one to use.

Swarthmore College, Swarthmore, Pa.

A Central Station on the Pacific Slope.

The California Electric Light and Edison Light & Power Company has three stations, two of which are located in the heart of the business portion of the city, and the third on the south side, near the water front. Stations A and B, in the center of the city, are in the same building, but the operation of the two is entirely separate. Station A was the original arc station, and was started before incandescent lighting had taken its place in the world. At present it contains thirteen 60-light arc dynamos, divided between machines of the Brush and Thomson-Houston types, and nine 1,000-light alternating dynamos (2,000 volts)—six Brush and three Slattery. The arc switchboard is an old and primitive affair in which the electrician takes no pride. It is soon to be replaced by a steel fireproof board of modern design.

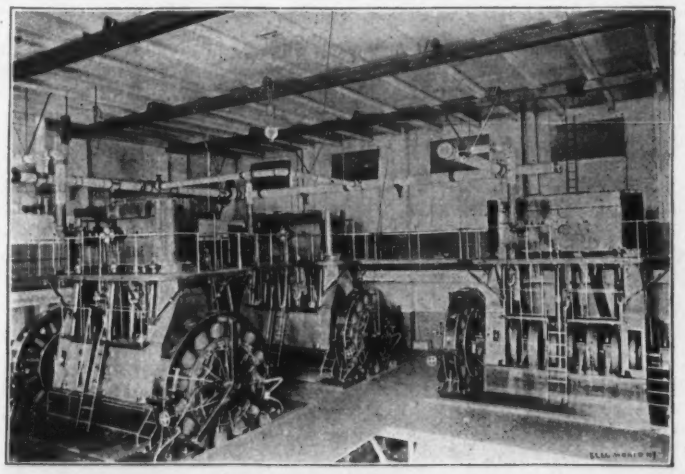
Station B is devoted entirely to the operation of arc dynamos, of which there are sixty-two, divided between Brush and Wood types, the Brush being 60-light and the Wood 80-light. They are used to a considerable extent for furnishing power by means of constant-current motors.

There are in all 2,500 arc lamps in circuit, the longest circuit being twenty-eight miles.

Station C is the Edison station, and is modern in all its appointments, as will be seen from the views given. The dynamos are of the Edison multipolar type, direct driven by triple expansion engines. There are at present installed one engine of 400 h. p., driving two 100 kw. dynamos, and three 800 h. p. engines, each driving two 200 kw. dynamos of fourteen poles each at 180 revolutions. Foundations are built, ready to receive two more of the larger units when the output of the station makes their use necessary. The smaller engine is sufficient for the present day load.

The foundation for all the dynamos consists of a solid block of concrete, covering the whole area of the dynamo room and extending five feet below the surface. Extra thicknesses of five feet are built up at the immediate location of the engines. This foundation rests on sand and is entirely disconnected from the walls or floor of the building, so there is very little vibration. The small amount can be judged from the fact that in taking the views given, the camera was standing on the gallery immediately over a running engine, and the exposure was three-quarters of an hour. The sharpness of detail is evidence of the absence of vibration.

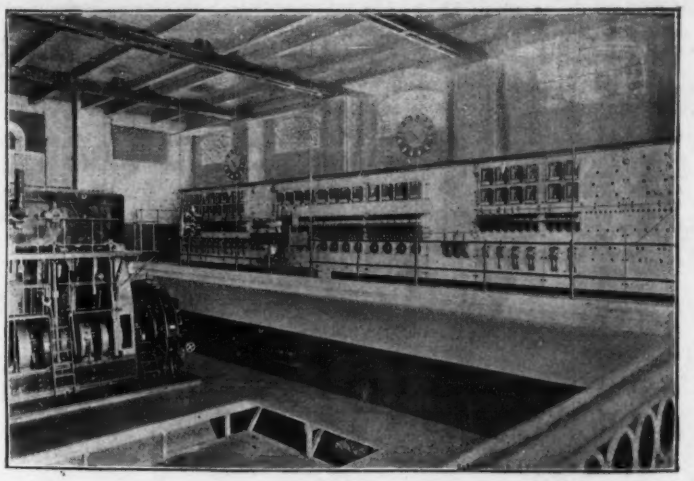
In accordance with the latest practice, the switchboard is placed on the gallery overlooking the dynamo room. It is fenced off at both ends by means of lattice-work iron doors, these being provided mainly to keep out strangers who may be permitted to see the station. The boards are of white marble, with the instruments, switches, etc., on the face and all busbars and connectors on the back. The busbars are made of 3x½-inch bars, but where extra capacity is required, two or three such bars are secured together,



STATION "C," SHOWING DIRECT COUPLED ENGINES AND DYNAMOS.

with faces in contact, instead of being separated to permit cooling. They are calculated on a basis of 1,000 amperes per square inch of section. For making connection with the dynamo leads, taking off feeders, etc., the connectors are given a length equal to the width of busbar, so that the area of contact is 9 square inches. The greatest current passing through such a contact is 2,000 amperes or 222 amperes per square inch of surface. The connectors are of bronze, and are supposed to carry about 600 amperes per inch, though the current density seldom reaches this figure.

Nothing in the nature of equalizers, boosters, etc., is used for regulation, the electrician being of the opinion that the constant loss incident to the use of these can be better applied as interest on the capital invested in extra copper. Extra feeders are put in, and the regulation effected by means of them and the field rheostats. Work begins at light loads with the rheostats thrown in the fields, and a man stationed at the switchboard, in plain view of the voltmeters connected with the feeding centers. As the load comes up and the pressure falls, resistance is thrown out of the fields, until it is so far exhausted that the pressure cannot be kept up. Then, when any feeding center shows a pressure below normal, extra feeders are cut in, so as to reduce the drop, and at the same time the rheostat is inserted in the field, so it can be used for regulation, as before. Obviously, by having a sufficient number of feeders properly calculated, good regulation can be maintained by this means, provided the attendant is sufficiently watchful.



STATION "C," SHOWING SWITCHBOARD.

Weston station voltmeters are used, each one being provided with red and blue lamps, and contacts arranged so one or the other will light up if too great a variation from normal pressure is permitted.

In the office of the electrician is a group of Bristol recording voltmeters, connected with the various feeding centers, by means of which an approximate record of the larger pressure variations is kept. They cannot, of course, register with extreme accuracy even the larger variations, and must fail to record small ones altogether, as the friction is appreciable. But for this purpose extreme accuracy is unnecessary.

There are also two other recording voltmeters, employing an entirely new principle. They are made after the designs of the electrician, Mr. F. E. Smith, and have never been described. They are very sensitive, and as the design is novel and ingenious, a description of them will not be uninteresting.

Referring to the view, a duplicate construction will be seen, one for the positive and the other for the negative side of the three-wire system. The Weston voltmeters shown are not connected with the recording meter, but simply show the actual voltage.

Considering one side only, the dial shown is rotated once every twenty-four hours by means of clockwork within the case, and the pressure is recorded on it by means of red ink carried in a well on the end of the hand. Underneath the Weston meter will be seen a round disc of ebonite, about 8 inches in diameter, carrying at the top a lamp and at the bottom a helix. These are in series, and are connected through pressure wires to the feeding center, which is the standard to which all the others are regulated. The lamp burns at about half-power, and is used because any variation of pressure, in virtue of which the current through the lamp changes, causes a considerable variation in the resistance of the filament, and hence makes the current change a maximum for any given change of pressure. A core within the helix has the lower half of iron and the upper half of brass. It is supported by two very flexible brass strips shown, which also form part of electric circuits. Near the ends of the core are two binding posts, with adjustable contacts, and in the normal position of the core the two strips lie just clear of these contacts. The motor shown is a small Edison slowspeed, series-wound motor, connected to run in either direction. The vertical rod shown is revolved by the motor through bevel gears, and revolves the disc through worm gearing, as shown. A wire is stretched between the disc and the hand on the dial, and when the disc rotates, the hand moves through a small arc and makes the record.

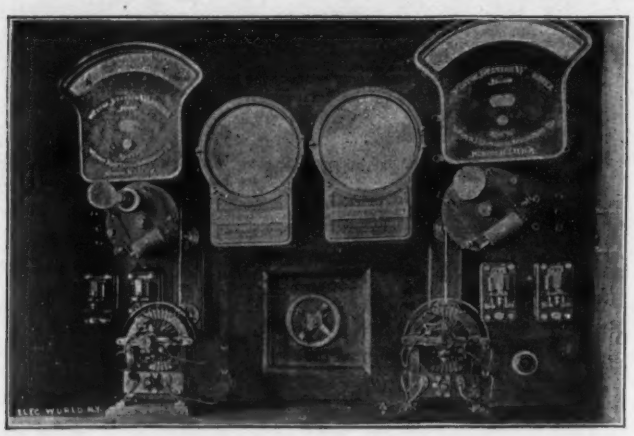
The core of the helix tends to fall by gravity until the lower strip comes against the lower contact, which tendency is opposed by the current through the helix, which draws the core upward until the upper strip makes contact.

The motor is connected with the service mains in the building, the relays shown being inserted to break the circuit. The current through the strip contacts simply controls the current through the relay, and only a battery current is necessary, thus reducing the spark, which would soon destroy the accuracy.

If the pressure falls below normal, the action of the helix is weakened and the core drops until the lower contact is closed, thus allowing current to pass to the motor in such a direction that the disc is revolved clockwise until a balance is obtained. This movement is registered on the dial. If the pressure rises, the core is drawn upward until the upper strip makes contact, when the motor revolves the disc counter-clockwise. Thus the slightest variation of pressure will cause the motor to revolve, and as considerable power is available for overcoming the friction, the instrument is very sensitive. In place of gravity, the action of the helix can be balanced against a flat spiral spring such as is used in Weston instruments.

Mr. Smith has applied this principle to an engine governor and a revolution indicator. Methods for doing this are obvious.

The only other arrangement of special importance connected with the station is the method of obtaining water for condensing purposes. Leading into the arc station near the water front is a culvert (the length of which is about one-eighth of a mile), which discharges water by natural flow into a well beneath the station. Powerful



Registering Voltmeter.

pumps then force it through iron pipes to the incandescent station, where it passes through the condensers and thence to the sewer. The saving by condensation is far more than the cost of forcing the water, interest on condensing plant, etc.

The arc dynamos are belted in groups from long countershafts, and cannot be slowed down singly. Some are shut down by short-circuiting the fields and some the armatures, the latter method being preferred. When the new switchboard is put up for Station A, arrangements will be made so that if an armature is burning out, and it is desired to throw the load on another machine, the act of plugging in the second will short-circuit the field or armature of the first.

The arc and alternating lines are all overhead, but for the low-tension system Edison tubes are used, these being the only subway circuits in the city, except a few for telephone service. A long gallery leading under the street carries the feeders to the tube ends.

There are altogether about 50,000 16-c. p. lamps wired in the city, the farthest from station being about 5 miles, the greatest distance for the low-tension system being 1½ miles.

The original station, A, has 1,400 h. p. of horizontal boilers, but the other two stations use vertical tubular boilers, as taking up less floor space. Station B has 5,600 h. p., and Station C, 7,000 h. p. Jones under-feed stokers are used and are said to give excellent results.

The company has recently adopted the practice of wiring buildings and charging only the actual cost. This means that the house owners can have the work done at the lowest possible rate, as the company's facilities are better than those of private contractors. It is expected many will take advantage of the good terms offered, and that there will be a consequent large increase in the station output.

The Inductance and Capacity of Suspended Wires.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

The inductance and capacity of conductors employed in transmitting continuous currents do not usually call for consideration. For example, those who have designed, installed or operated Edison systems of incandescent lighting do not usually have occasion to inquire into the inductance or capacity of their circuits. On the other hand, where intermittent or alternating currents are employed, as in telegraphy or alternating current transmission, the inductance and capacity of the circuit often form important factors in their operation, and thus claim the attention of the electrical engineer.

Some of the problems connected with telephony and with the distribution of power by alternating currents, demand a knowledge of the inductance and capacity of the conductors, in addition to their resistance and insulation. To meet this demand in the case of overhead wires, the tables and curves which follow have been constructed.

Before considering these tables and curves, a few remarks on capacity may be acceptable, a subject which gives rise to much misunderstanding.

The capacity per mile of 5280 feet each of a pair of parallel wires (Fig. 1), of radius, a, suspended in air at an interaxial distance, d, is in microfarads

$$C = \frac{0.01942}{\log \frac{d}{a}} \qquad (1)$$

For example, if two bare but insulated No. 6 B & S. wires, each 0.081 in radius, are suspended in air at an interaxial distance of 24 inches, their capacity per mile will be

$$\frac{0.01942}{\log. \frac{24}{0.081}} = \frac{0.01942}{\log 296.3} = \frac{0.01942}{2.47173} = 0.007858 \text{ microfarads.}$$

In other words, if a battery of one volt E. M. F. were connected with its terminals to one mile of each of these wires, one wire would

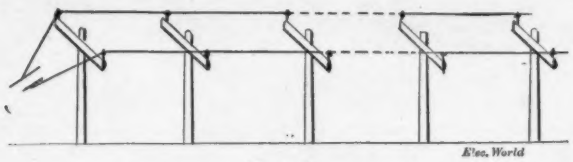


Fig. 1.

have 0.007858 coulomb of positive, and the other wire, 0.007858 coulomb of negative charge. (Fig. 1.)

This formula assumes that the distance between the wires is large, compared with the radius of the wire, as, indeed, is the usual case with overhead conductors. When, however, the wires are brought so close together that $\frac{d}{a}$ is a small number, their capacity is slightly greater than that given by the formula. The correction amounts to .5 per cent. when $\frac{d}{a} = 10$ and 2.6 per cent. when $\frac{d}{a} = 5$

When, as in telegraphy, a ground return circuit is employed, and the conductor is situated at an elevation h above the conducting surface of the ground, the capacity of that conductor is just twice as great as though the ground were removed and a return wire placed parallel at an interaxial distance $2h$ from the conductor. Thus in Fig. 2, if A be the conductor of radius a situated at the elevation h above the *conducting* ground level $G\ L$, the capacity will be the same as if the ground were entirely removed and a duplicate or similar return wire B were employed as the return circuit of A at a distance h below $G\ L$ or $2h$ from A, so that since the capacity of A with the imaginary wire B would be $\frac{0.01942}{\log \frac{2h}{a}}$ microfarads per mile, the capacity of A to ground will be

$$\frac{0.03884}{\log \frac{2h}{a}} \text{ microfarads.} \qquad (2)$$

Thus, a No. 9 A. W. G. wire of radius 0.0572 inches, suspended at a distance of 20 feet, or 240 inches above the ground, should have a capacity of

$$\frac{0.03884}{\log \frac{480}{0.0572}} = \frac{0.03884}{\log 8391} = \frac{0.03884}{3.9238} = 0.0099 \text{ micro. per mile.}$$

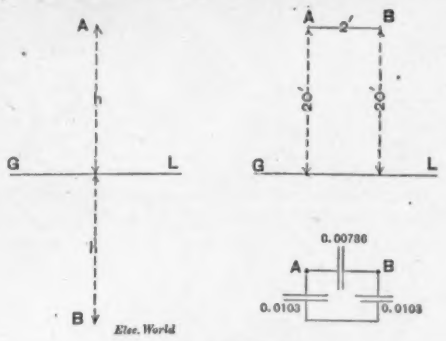
Since, however, the measured capacity of suspended wires is often 50 per cent. greater than their capacity calculated in this way, it

has sometimes been supposed that the insulators upon which the wire is supported account for the excess. While the presence of the insulators, with their pins and supporting cross arms, must add to the capacity of the wire, a closer examination shows that even where iron poles and brackets are used, with iron pins in the insulator connected with the ground, and where the outer surface of the insulator is covered with a film of moisture, the capacity of the line can only be increased from this cause by about 1-500ths of a microfarad per mile; while under ordinary conditions the additional capacity due to insulators can only be a small fraction of this amount, and is for all practical purposes negligible.

The excess of the measured capacity over the capacity calculated by formula (2) appears to be entirely accounted for by the presence of neighboring wires, supported on the same poles, as shown by Mr. Oliver Heaviside, in 1880.

If a wire be suspended on poles among a number of other parallel wires, its capacity will not be effected if these wires are all perfectly insulated, but if they are grounded or imperfectly insulated, its capacity may be more than doubled by their presence.

It is commonly supposed that when two parallel wires are supported on poles, their capacity, when insulated from the ground, as



FIGS. 2 AND 3.

in Fig. 1, depends largely upon their distance above the surface of the ground. Thus, if the two wires have in free space or at an indefinitely great distance above the surface of the earth, a capacity of 0.00786 micros per mile, according to formula (1), and each would have a capacity to ground of $+\frac{0.03884}{\log \frac{480}{0061}} = 0.0103$ microfarads per mile, according to formula (2), therefore, as represented in Fig. 3, it might be supposed that the total capacity between the wires at 20 feet elevation would be $0.00786 + \frac{0.0103}{2} = 0.013875$ microfarads per mile.

Such, however, is not the case, and as long as the insulation of the wires is maintained, their elevation above the surface of the ground has practically no effect upon their capacity. Thus, while formula (1) gives their capacity per mile for an infinite elevation, as 0.00786 microfarads, their capacity per mile for 5 feet elevation as 0.00788 microfarads, and their capacity per mile for 1 foot elevation, as 0.008362 microfarads, descent to within 5 feet of the ground only increases the capacity by about ¼ of 1 per cent., and descent to within 1 foot of the ground only adds about 6.4 per cent. Similarly, the presence of other grounded wires in the neighborhood has very little influence on the capacity of the insulated pair. For all practical purposes, therefore, the capacity of two overhead insulated wires is assigned by formula (1), and is not affected by the prox-

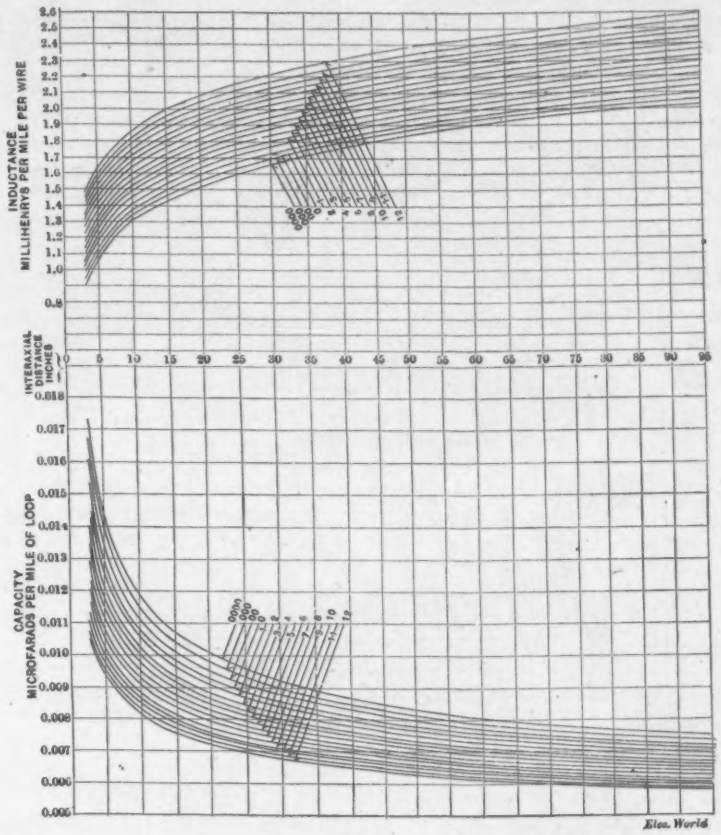

INDUCTANCE MILLIHENRYS PER MILE PER WIRE
INTERAXIAL DISTANCE INCHES
CAPACITY MICROFARADS PER MILE OF LOOP
Elec. World

FIG. 4.

imity of the ground or of other wires. Their induction is also for each wire:

$$l = 0.0805 + 0.741 \log \frac{d}{a} \text{ millihenrys per mile.} \quad (3)$$

For No. 6, A.W.G. wires at 24" $\log \frac{d}{a} = 2.47173$ as previously observed, so that $l = 0.0805 + 1.8315 = 1.912$ millihenry per mile. The inductance of the loop formed by both wires would be twice this amount, or 3.824 millihenrys per mile.

An iron telegraph or telephone wire has about 12 millihenrys per mile more inductance than a copper wire, so that for each pair of iron wires we may take

$$l = 12.08 + 0.741 \log \frac{d}{a} \text{ millihenry per mile approx.} \quad (4)$$

The following tables and curves (Fig. 4) indicate the capacity and inductance of insulated, overhead wires, in microfarads and millihenrys per mile of 5,280 feet.

TABLE OF INDUCTANCES PER MILE OF 5,280 FEET OF COPPER WIRE WHEN SUSPENDED IN PARALLEL PAIRS—MILLIHENRYS.

Interaxial Dis. Ins.	0000 0.460"	000 0.4096"	00 0.3648"	0 0.3249"	1 0.2893"	2 0.2576"	3 0.2294"	4 0.2043"	5 0.1819"	6 0.1620"	7 0.1443"	8 0.1285"	9 0.1144"	10 0.1019"	11 0.09074"	12 0.08081"
3	0.907	0.944	0.982	1.019	1.056	1.094	1.131	1.168	1.206	1.243	1.280	1.317	1.355	1.392	1.429	1.467
6	1.130	1.168	1.205	1.242	1.280	1.317	1.354	1.392	1.429	1.466	1.503	1.540	1.578	1.615	1.652	1.690
9	1.260	1.298	1.335	1.372	1.410	1.447	1.485	1.522	1.559	1.596	1.634	1.671	1.709	1.746	1.783	1.820
12	1.353	1.391	1.498	1.465	1.502	1.54	1.577	1.614	1.652	1.689	1.727	1.764	1.801	1.838	1.875	1.913
18	1.484	1.521	1.558	1.596	1.633	1.671	1.708	1.744	1.781	1.820	1.857	1.894	1.931	1.968	2.007	2.044
24	1.576	1.614	1.651	1.688	1.725	1.764	1.800	1.838	1.875	1.912	1.949	1.986	2.025	2.061	2.099	2.135
30	1.648	1.686	1.723	1.760	1.797	1.835	1.871	1.910	1.947	1.984	2.021	2.058	2.097	2.134	2.171	2.208
36	1.707	1.745	1.784	1.818	1.856	1.893	1.931	1.968	2.005	2.043	2.079	2.117	2.155	2.192	2.229	2.266
48	1.799	1.836	1.874	1.911	1.949	1.986	2.023	2.061	2.099	2.135	2.172	2.209	2.248	2.285	2.322	2.359
60	1.871	1.909	1.946	1.982	2.023	2.058	2.095	2.132	2.169	2.208	2.245	2.282	2.319	2.356	2.393	2.432
72	1.930	1.968	2.005	2.042	2.079	2.116	2.154	2.192	2.229	2.266	2.303	2.340	2.376	2.415	2.452	2.489
84	1.971	2.016	2.053	2.092	2.128	2.166	2.203	2.240	2.277	2.312	2.351	2.389	2.427	2.464	2.502	2.539
96	2.023	2.059	2.097	2.134	2.172	2.210	2.246	2.283	2.321	2.358	2.395	2.433	2.470	2.507	2.546	2.582

TABLE OF CAPACITIES PER MILE OF 5,280 FEET OF WIRE WHEN SUSPENDED IN PARALLEL PAIRS—MICROFARADS.

D	0000	000	00	0	1	2	3	4	5	6	7	8	9	10	11	12
3	0.01741	0.01665	0.01597	0.01533	0.01475	0.01420	0.01369	0.01322	0.01278	0.01238	0.01199	0.01163	0.01129	0.01097	0.01067	0.01038
6	0.01371	0.01324	0.0128	0.01239	0.01200	0.01164	0.01130	0.01097	0.01067	0.01038	0.01011	0.009858	0.009607	0.009378	0.00915	0.008942
9	0.01222	0.01182	0.01147	0.01114	0.01082	0.01052	0.01025	0.00998	0.009736	0.009491	0.009265	0.009044	0.008836	0.008838	0.008451	0.00827
12	0.01130	0.01098	0.01068	0.01039	0.01012	0.009862	0.009614	0.009384	0.009154	0.008948	0.00874	0.008548	0.008362	0.008188	0.008018	0.007851
18	0.01026	0.009988	0.009736	0.009498	0.009268	0.009050	0.008842	0.008646	0.008458	0.00827	0.00810	0.007934	0.007776	0.007623	0.007470	0.007328
24	0.00962	0.009384	0.009160	0.008948	0.008746	0.00855	0.008363	0.008188	0.008018	0.007858	0.007702	0.007552	0.007402	0.007263	0.007130	0.007002
30	0.00918	0.008960	0.008745	0.008565	0.008378	0.008204	0.008032	0.007864	0.007728	0.007558	0.007415	0.007274	0.007136	0.007006	0.006882	0.006764
36	0.00885	0.008648	0.008460	0.008279	0.008104	0.007938	0.007777	0.007622	0.007477	0.007332	0.007199	0.007066	0.006936	0.006815	0.006696	0.006584
48	0.008374	0.008196	0.008020	0.007862	0.007707	0.007550	0.007410	0.007262	0.007130	0.007000	0.006877	0.006758	0.006737	0.006526	0.006419	0.006315
60	0.008034	0.00787	0.007710	0.007564	0.007406	0.007274	0.007143	0.007014	0.006888	0.006764	0.006646	0.006536	0.006427	0.006322	0.006221	0.006120
72	0.007780	0.007623	0.007476	0.007336	0.00720	0.007070	0.006938	0.006815	0.006696	0.006584	0.006475	0.006368	0.006265	0.006162	0.006065	0.00591
84	0.007578	0.007432	0.007292	0.007154	0.00703	0.006898	0.006780	0.006662	0.006550	0.006447	0.006337	0.006231	0.006132	0.006037	0.005941	0.00585
96	0.007410	0.007270	0.007136	0.007008	0.00688	0.006758	0.006642	0.006530	0.006424	0.006319	0.006218	0.006116	0.006020	0.005930	0.005837	0.005749

Experiments on Two-Phased Motors.*

BY LOUIS DUNCAN, S. H. BROWN, W. P. ANDERSON AND S. Q. HAYES.

Within the last few years rotary field motors have been greatly improved, and the conditions for successful design are moderately well understood. The problem has been attacked mathematically, and results have been obtained, which, while interesting, have not been submitted to the test of experiment. The mathematical treatment is difficult, unless many essential phenomena are omitted; indeed, it is only lately that the solution of the case of a motor supplied from a constant potential circuit has been undertaken, and as this is the condition of actual practice, the results, even with their evident limitations, are important and interesting. The phenomena that occur in the armatures of these motors are of special importance, but they have not yet been submitted to experimental investigation.

The experiments of which this article is a description were intended for the purpose of developing a method of obtaining the current and electromotive force curves of multiphase motors, and

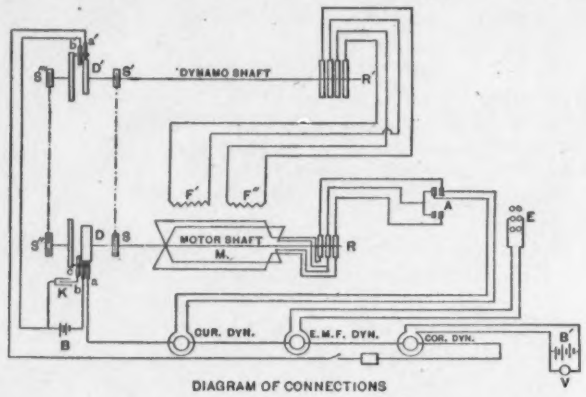


FIG. 1.

of applying it to a two-phase 2-h. p. Tesla motor kindly furnished by the Westinghouse Electric Manufacturing Company. While the results are probably correct for the machine tested, yet as the motor was small, with inward projecting pole pieces, the results will differ considerably from those that would have been obtained on a larger machine, or one without projecting pole pieces. It was impossible for us to get any other machine, and the development of a method is, we think, of as great importance as the results themselves.

In a rotary field motor, if the resultant field is not exactly uniform, but presents some irregularities, then if the difference between the speed of the field and the speed of the armature is not a multiple of both, the armature electromotive force will not in general be a periodic curve, because if we consider an armature coil enclosing a maximum number of lines of induction, then when it again includes the maximum number the field will be in a different position with respect to the poles, and its maximum value may be

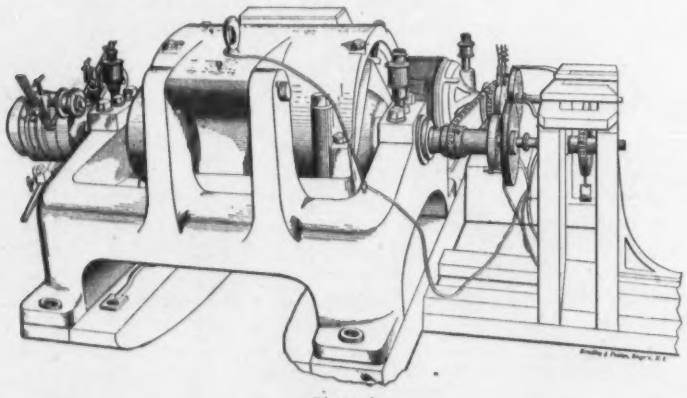


FIG. 2.

different. Or, to put it another way, if the difference of the speeds of the field and armature is not a multiple of both, then any particular armature coil will not have the same relative position with respect to both the field and the pole pieces in its successive positions of maximum induction. It is necessary, then, in order to obtain periodic armature currents, that some form of gearing be employed.

*A paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

If large machines are to be tested where it would be inconvenient to transmit a large amount of power by gearing, the motor may be loaded until the desired speed of test is approximately attained, when a very light gearing between the dynamo and motor will serve to keep this speed constant, the gearing serving simply to check any small tendency toward a change of speed. In our own experiments, the power to be transmitted was small, and the con-

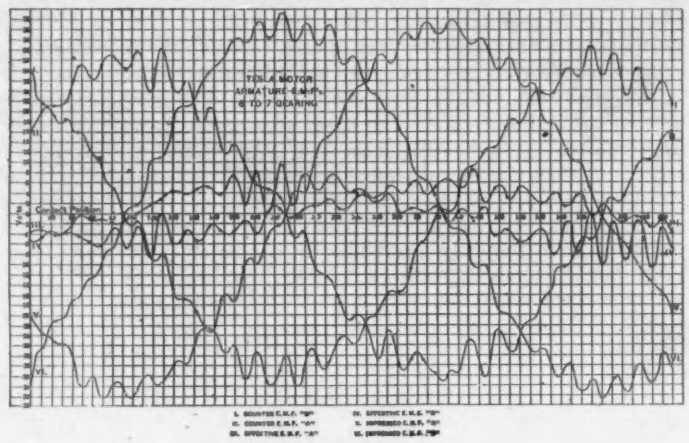


FIG. 3.

struction of the motor was such that we had no room for a gearing and for a coupling to a load. We consequently geared the motor to the dynamo, the motor energy being given back to the dynamo.

The apparatus experimented on consisted of a 25-h. p. two-phased dynamo, an ordinary constant current machine, supplied with four (4) collecting rings, and one (1) two-phase, 8-pole, 2-h. p. Tesla motor. The electromotive force of the dynamo, as may be seen from the curves, was practically a sine curve. In our work the motor was not run up to its full capacity, as we were limited by the amount of power the gearing would safely transmit. We cannot better describe the armature winding of the motor than by quoting part of a letter written me by Mr. Charles F. Scott, of the Westinghouse Company:—

"The one you have, has, however, 41 slots. The odd slot was placed in this motor so that the relation of the armature teeth to the field poles was different in different parts of the circumference,

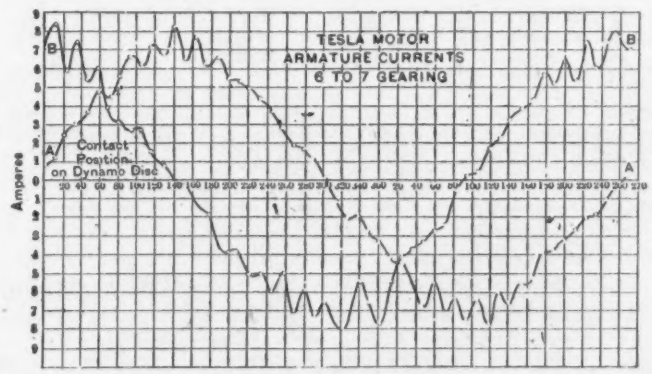


FIG. 4-

and the forty (40) incipient dead points which might have occurred were avoided by the addition of the extra slot. The winding consists of four (4) layers. The first and third are exactly similar and coincident in the slots occupied, and the second and fourth are similarly related. The four coils in each layer are connected in series and short circuited."

The idea was to make the mutual induction of an armature coil, with respect to the poles, a sine curve. Of course, with a limited number of slots it is impossible to have the mutual induction of the field and armature exactly a sine curve. But it is possible to very nearly accomplish this, especially in large armatures, and the importance of it is beginning to be appreciated. Mr. Scott, of the Westinghouse Company, was one of the first to appreciate the importance of the armature winding and the proper method of doing it, and he deserves much credit for his quiet and persistent work, which has resulted in the production of excellent motors, instead of voluminous papers. It is, of course, true that the period of the armature current is the sum of the periods of the field and the armature. As we wished to obtain the curve of the armature cur-

rent by the contact method, it became necessary to get contacts whose period was the sum of the field and armature periods. This was obtained by an arrangement of apparatus shown in Fig. 1. In the figure, S and S′ are the two sprocket wheels which gear the two machines together and give them the desired relative speeds. S″ and S‴ are two others, which gear the graduated discs which carry the brushes. D and D′ are the two instantaneous contact discs, one mounted on each shaft, and a, b, c, a′, b′ are the wiping brushes. K is a condenser, and B a charging battery; b and c make the circuit through the battery and condenser once every revolution, thus keeping the condenser charged. When a and a′ make simultaneous contact, the battery circuit is broken and the condenser is discharged through the movable coils of the dynamometer, which are all connected in series. F and F′ are the motor fields; R and R′ the rings of the motor and dynamo respectively. E is a double-pole, double-throw switch, to which are connected the terminals whose potential difference curves are desired. M is the motor armature, and A is a switch in the circuit of the current instrument. B′ is a battery which sends a steady current through the large coils of a dynamometer. This dynamometer is used as a

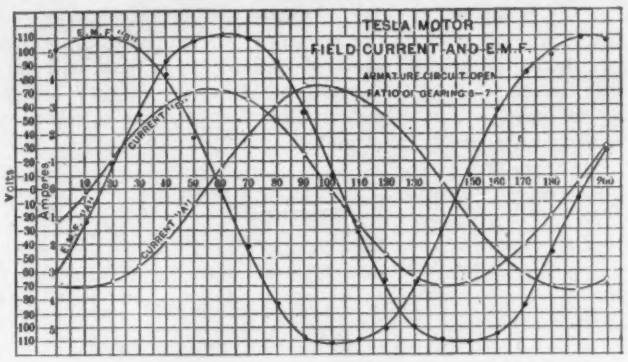


FIG. 5.

correcting instrument, and the resistance in the condenser circuit is regulated to keep its deflection constant. If the brushes are set together on the contacts, and then the two machines revolve with a given speed ratio, say 4 to 3, the brushes will again be simultaneously on the contacts when the machines have made respectively 4 and 3 revolutions. If the ratio was 7 to 6, the machines would make 7 and 6 revolutions before the contacts would again be coincident. In this way we obtained the needed instantaneous current.

After obtaining one point on the curve in this way, and wishing to obtain another point, we must shift our brushes through angular distances proportional to the speed ratio of the two machines; otherwise they would not make simultaneous contact again. Having shifted them in this ratio (say, if the ratio is 6 to 7, we would shift 10 degrees on the dynamo discs, and 6-7th of 10 degrees on the motor disc), we obtain another point on the curve. To accomplish

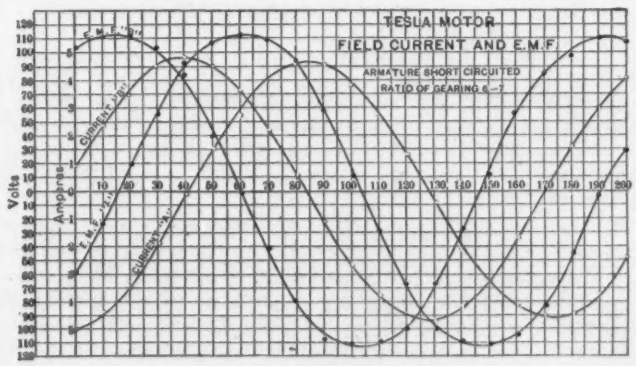


FIG. 6.

this easily, we gear the brushes together in the same ratio as the armatures are geared, as is shown in Fig. 1. Our gearing, both for the brushes and armatures, consisted of sprocket wheels and chains and was very satisfactory.

As the machine we tested was small, and was run much below its rated electromotive force, it was not of course particularly efficient, and as the armature efficiency is approximately the ratio of the armature speed to the field speed, this ratio was comparatively small, thus enabling us to use for measuring it a form of dynamometer which has been described before, and which was invented by one of us for obtaining such curves. It consists of a stationary coil carrying the current whose curves are to be obtained, and a movable coil through which passes an instantaneous direct current, obtained by making the circuit on the armature discs before described. If this instantaneous current occurs when the alternating current is zero, we will get no deflection of the instrument. If it occurs when

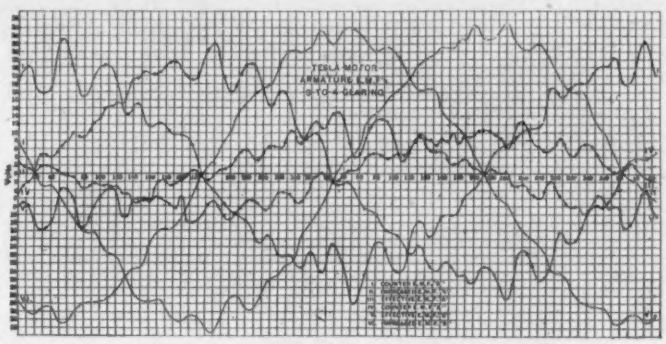


FIG. 7.

the alternating current is maximum, we will get a maximum deflection, and in general the deflection will be proportional to the instantaneous value of the alternating current. The dynamometer used had a long period, and was well dampened, and we had no difficulty in reading, even when the period of the armature current was as much as one-quarter second.

If very efficient machines were to be tested, where the period of the armature is very large indeed, then some electrometer method or a telephone method would be used, or the deflection of a galvanometer needle in the field of the current could be easily photographed.

The curves we have obtained are as follows: The electro-motive force applied to the armature; effective electro-motive force of the armature; the counter electro-motive force of the armature; the armature current; the value of field electro-motive force and current for open and closed armature circuit. These for ratios of 3 to 4 and 6 to 7.

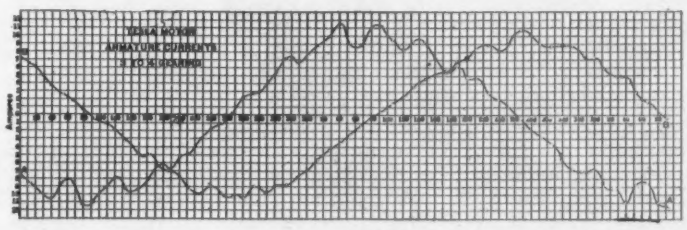


FIG. 8.

We also obtained the various currents and electro-motive forces when the armature was held stationary, with and without resistance in the outside circuit. There are really three distinct sets of curves —those relating to the 3-to-4 gearing, those for the 6-to-7 gearing, and those in which the armature was stationary. The angular positions do not correspond for the first two sets. For the second and third they very nearly correspond. This is due to the fact that we did not at first clearly appreciate the importance of permanently fixing the relative positions of the armatures of the two machines. Afterward we made marks on each armature, and if for any reason we took off the gearing, we replaced it so these marks came opposite points which we fixed on the frames of the two machines. It should also be remarked that the curves for the two sets of armature coils marked A and B should not in general present the same irregularities, as their relative positions, with respect to the poles and the resultant field, are different. The dynamo being a four-pole machine, this must be taken account of in calculating the angles on the base line. In Figs. 3 and 4, the contact positions should be multiplied by two. The length of an armature curve, in terms of the position of the dynamo brush, should be $360\times4\text{-}2=7{,}200$, in the case of the 3 to 4 gearing, and $360\times7\text{-}2=12{,}60$ for the 6 to 7 gearing. We have not the same confidence in the results of the 3 to 4 gearing as for the 6 to 7 gearing, the latter being taken from several sets of observations, which checked very well.

The curves of the applied electro-motive force (Curves V and VI, Fig. 3, and II and VI, Fig. 7) are obtained in the following man-

ner: The armature was held stationary, while the field revolved at its normal rate. The reading of our electro-motive force dynamometer then gave us a point on the electro-motive force curve. The armature was then moved through a given angle, while the brush on the dynamo disc was moved through an angle corresponding to the ratio of gearing of the two machines. What we obtained was the electro-motive force applied to the armature when there was no current flowing through it and when the gearing was 3 to 4 or 6 to 7, according to the relative movement we gave the motor armature

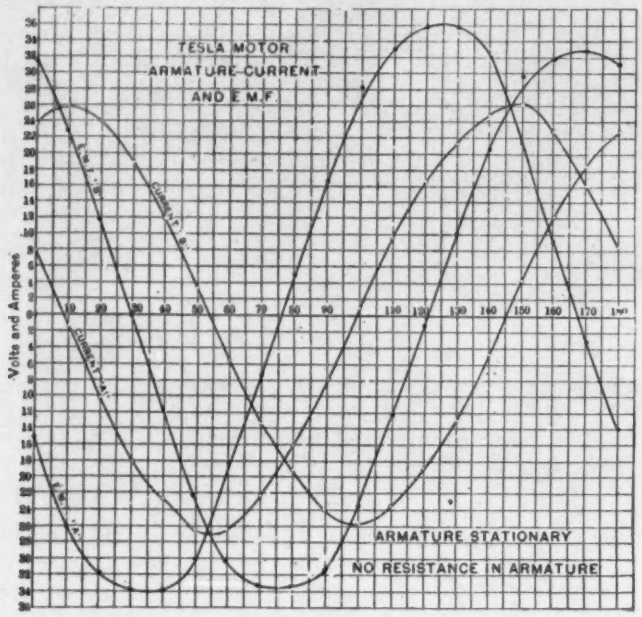


Fig. 10.

and the dynamo brush. It should be remarked that all of the armature curves marked electro-motive force curves are obtained when the armature circuit is open, and therefore do not correspond to the actual condition of affairs when the armature is closed, as they do not contain the effects of armature reaction and self-induction.

The effective electro-motive force of the armature given in Curves III and IV, Fig. 3, and III and IV, Fig. 7, were simply measured by opening the armature circuit and getting the potential difference on the motor terminals when the motor was geared to the dynamo with ratios of 6 to 7 and 3 to 4. The difference between these curves and the curves of impressed electro-motive force is the counter electro-motive force, and is given by Curves I and II, Fig. 3, and I and IV, Fig. 7. We could have obtained the counter electro-motive force by supplying the fields with continuous currents whose ratio to one another would be that of the two-phase currents, and varying the relative values of these currents as we vary the point of contact of our instantaneous current. This would have been a laborious task, and was not necessary. It was not possible

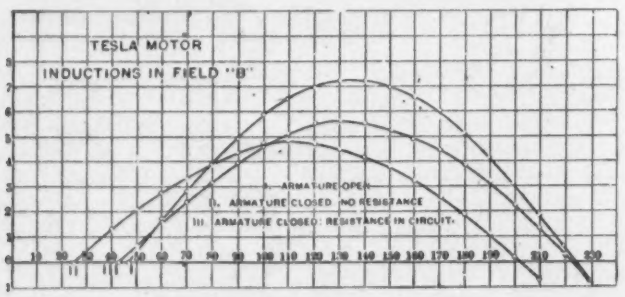

TESLA MOTOR
INDUCTIONS IN FIELD "B"
II. ARMATURE OPEN
III. ARMATURE CLOSED: NO RESISTANCE
III. ARMATURE CLOSED: RESISTANCE IN CIRCUIT.

Fig. 11.

to obtain these quantities by direct observation when the armature circuit was closed and when the machine was running under normal conditions.

In Fig. 4 is given the armature current of the motor with a gearing of 6 to 7. If we compare these curves with those obtained when the gearing is 3 to 4, we will see that the current is more irregular with the higher efficiency than with the lower. Again, comparing the curves of effective electro-motive force for the two gearings, we see again that the irregularity is greater with the higher efficiency. If we consider that the current would follow this curve of effective electro-motive force, but for the armature reactions and self-induction, we can see that these effects have their good as well as evil side. The effective electro-motive force is of course the difference between the applied and the counter electro-motive forces, and if these are irregular their difference becomes the more irregular as they are the more equal in value, that is, as the efficiency of the motor is higher. So that, while in this machine, whose maximum armature efficiency was made about 87 per cent., the irregularity is considerable, it would be very much exaggerated in a larger motor whose armature efficiency might be 97 per cent. or 98 per cent.; and in this case great care should be taken to produce a perfectly regular field. The effect of the armature reaction and self-induction is to decrease these irregularities.

If we consider for a moment the theory of the two-phased motor, we will remember that the armature efficiency is theoretically (leaving out losses in the field iron) $p \div p_1$ where p and p^1 are respectively the angular velocities of the field and of the motor armature. We will also remember that the lag of the armature current behind the effective electro-motive force is taken as $\tan \Theta = \frac{(p\,p')\,L}{r}$. If we look at the curves, however, obtained with the motor experimented on, we will see that the armature current is irregular, and therefore the actual heating would be greater than that calculated from sine curves—that is, the armature efficiency is always less and the drop in speed is always greater than the theoretical value, and may be very much less if the armature current is irregular. As has

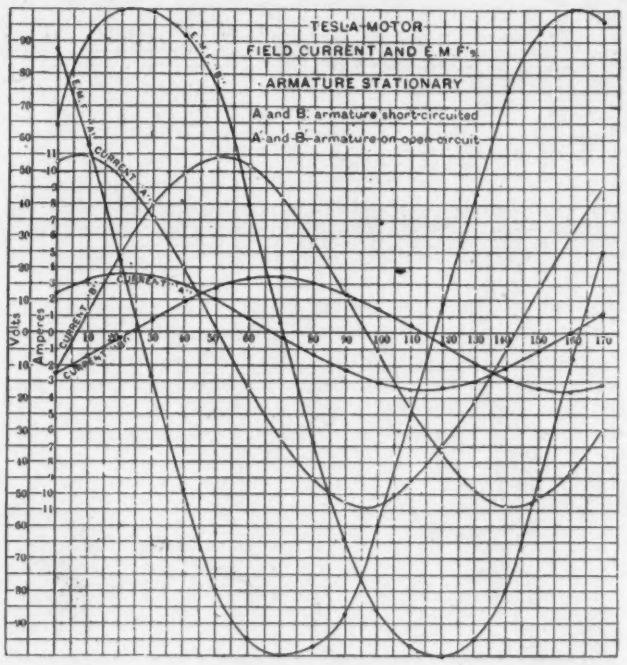


Fig. 9.

been pointed out, this fluctuation in the armature current would be exceedingly great if the self-induction and armature reaction of the motor did not tend to wipe it out, the effect of the self-induction being to damp the most the waves of shorter period—that is, the irregularities.

It seems to us that the most important curves we have obtained are those of applied and counter electro-motive forces, effective electro-motive force, and the armature current. They show at once the great importance of designing a machine whose applied and counter electro-motive forces are both sine curves, and the method may be easily used to experiment on actual machines and to find out if this condition is fulfilled. Again, the comparison of the effective electro-motive forces, with no armature current, with the fall of potential due to the armature current, shows us that there is some beneficial effect from self-induction in the armature. The principal results show that the special machine does not give us regular currents and electro-motive forces, but it is to a large extent due to the fact that in these small machines considerations of economy make it necessary to wind the field coils on spools, instead of winding them through slots cut in the field iron.

In designing a motor to give absolutely regular electro-motive force curves, we must take two things into account: The field due to the dynamo current must be regular, and the armature winding

must be such that it will give a regular electro-motive force in a regular field. To satisfy this condition in the field windings, projecting pole pieces should certainly be avoided. To satisfy the condition in the armature would require an infinite number of armature windings, but it can be practically satisfied in the higher machines with a reasonable number of windings. It must not be understood that it is specially easy to accomplish this. Figs. 5 and 6 give us the input of the motor at full load and with an open armature, with a 6 to 7 gearing. Figs. 9 and 10 show the field and armature electro-motive forces and currents when the armature is stationary, and in one case short circuited, and in the other case has outside resistances in its circuit. Fig. 11 gives in arbitrary units the induction through a coil wound around one of the pole pieces, under the conditions stated.

We do not wish to add to an already lengthy paper a prolonged discussion of the curves we have given, especially as we hope to be able to experiment on a larger machine, the results from which will be of much greater importance; but we think that the curves we have given show that the design of rotary field motors requires careful experimental study, and we believe that such a study may be easily made, even for machines of large capacity.

Practical Notes on Dynamo Calculations.—VIII.

BY ALFRED E. WIENER.

d.—Total Energy Loss in Armature.

The total energy transformed into heat in the armature is the sum of the energies consumed by the winding, by hysteresis, and by eddy currents:

$$W_a = w_a + w_h + w_e \qquad (42)$$

W_a = total watts absorbed in armature;
w_a = watts consumed by armature winding, formula (35);
w_h = watts consumed by hysteresis, formula (39);
w_e = watts consumed by eddy currents, formula (41).

For comparison, in the following Table XXVIII., the energy losses due to hysteresis and eddy currents, expressed in various units of the metric as well as the English system, are compiled:

TABLE XXVIII.—SPECIFIC ENERGY DISSIPATION IN ARMATURE CORE.

Magnetic Density.		Hysteresis loss for sheet iron at frequency of 1 magnetic cycle per sec.				Eddy current loss for .030" (.075 cm.) lamination, at 1 cycle per second, proportional to frequency.			
Gausses.	Lines of Force. Per sq. inch.	Per cm^3	Per cu. ft.	Per kg.	Per lb.	Per cm^3	Per cu. ft.	Per kg.	Per lb.
		Watts.	Watts.	Watts.	Watts.	Watts.	Watts.	Watts.	Watts.
2000	12900	.00007	1.98	.0091	.0041	.0000004	.011	.000051	.000023
3000	19350	.00013	3.68	.0140	.0077	.0000009	.026	.000119	.000054
4000	25800	.00020	5.75	.0265	.0120	.0000016	.046	.000212	.000096
5000	32250	.00029	8.20	.0378	.0171	.0000025	.071	.000327	.000148
6000	38700	.00039	11.03	.0508	.0230	.0000036	.102	.000471	.000213
7000	45150	.00050	14.15	.0652	.0295	.0000049	.139	.000640	.000290
8000	51600	.00062	17.5	.0806	.0365	.0000064	.181	.000833	.000377
9000	58050	.00074	20.9	.0963	.0436	.0000081	.229	.001054	.000478
10000	64500	.00087	24.6	.1133	.0513	.0000100	.283	.001303	.000590
11000	70950	.00102	28.3	.1303	.0590	.0000121	.343	.001580	.000715
12000	77400	.00118	33.1	.1524	.0690	.0000144	.408	.001878	.000850
13000	83850	.00134	37.9	.1745	.0790	.0000169	.479	.002204	.000998
14000	90300	.00150	42.7	.1966	.0890	.0000196	.555	.002553	.001157
15000	96750	.00168	47.5	.2193	.0990	.0000225	.637	.002923	.001328
16000	103200	.00187	52.9	.2440	.1103	.0000256	.725	.003340	.001512
17000	109650	.00206	58.3	.2680	.1212	.0000289	.818	.003770	.001708
18000	116100	.00225	63.7	.2932	.1328	.0000324	.917	.004220	.001911
19000	122550	.00246	69.6	.3200	.1450	.0000361	1.022	.004710	.002130
20000	129000	.00267	75.6	.3480	.1575	.0000400	1.133	.005225	.002362

17.—Radiating Surface of Armature.

The radiating surface, or cooling surface, of an armature is that portion of its superficial area which is in direct contact with the

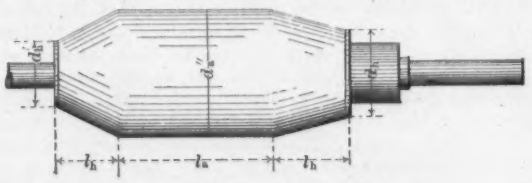


FIG. 17.

surrounding air, and which consequently gives off the heat generated in the winding and in the iron core. It is evident that the shape and the construction of the armature and the arrangement of the field determine the size of this radiating portion of the armature surface. In drum armatures, for instance, only the external surface is liberating heat, while in ring armatures, according to design, either the external surface only or any two or three sides of the cross section, or even the entire superficial area may act as cooling surface.

a.—Radiating Surface of Drum Armatures.

In drum armatures the dead portion of the winding forms two "*heads*" at the ends of the cylindrical body, and the external area, extending over the cylindrical part, as well as over these two conical heads, is the radiating surface of the armature. In order to calculate the cooling area of a drum armature, it is therefore necessary to first determine the size of the armature heads.

The length of the heads, l_h, Fig. 17, depends upon the diameter of the armature, the size of the shaft and the height of the winding space, and can be found from the empirical formula:

$$l_h = k_7 \times d''_a + 2 \times h_a, \qquad (43)$$

where: l_h = length of armature heads, in inches;
k_7 = constant, depending upon the size of the armature (see Table XXIX.);
d''_a = external diameter of armature, in inches;
h_a = height of winding space, in inches.

The coefficient k_7 in this formula varies with the slope of the head, and this, in turn, depends upon the ratio between the diameter of the armature and the thickness of the shaft. For in large

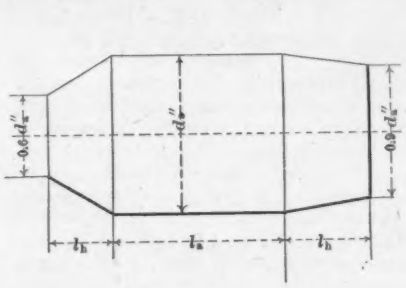


FIG. 18.

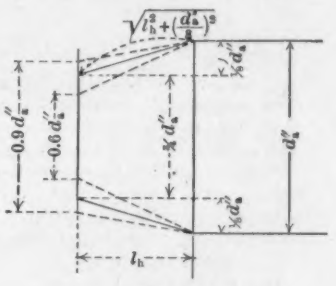


FIG. 19.

machines the shaft bears a smaller proportion to the armature diameter than in small ones, and therefore in large armatures there is comparatively much more room between the shaft circumference and the body periphery than in small armatures, and since the diameter of the head must never exceed that of the armature itself, it is evident that the slope of the head is smaller, and consequently its relative length is larger in the smaller armatures. The following Table XXIX. gives the values of this coefficient for the various sizes of drum armatures:

TABLE XXIX.—LENGTH OF HEADS IN DRUM ARMATURES.

External Diameter of Armature. d''_a	Value of k_7	Average Length of heads. l_h Inches.
Up to 6"	.60 to .50	$l_h = .55 \times d_a'' + 2\,h_a$
" " 12"	.55 to .45	$= .50 \times d_a'' + 2\,h_a$
" " 18"	.50 to .40	$= .45 \times d_a'' + 2\,h_a$
" " 24"	.45 to .35	$= .40 \times d_a'' + 2\,h_a$
" " 30"	.40 to .30	$= .35 \times d_a'' + 2\,h_a$

As to the diameters at the ends of the heads, that of the front head, d_h, at commutator end of armature, is generally made from 0.75 d''_a to d''_a, while the diameter of the end washer of the back head, d_h, ranges in size from 0.5 d''_a to 0.75 d''_a. Taking $d_h = 0.9\ d''_a$ as the average diameter of the front head, and $d''_h = 0.6\ d''_a$ as that of the back head (Figs. 18 and 19) we obtain the following formula for the radiating surface of a drum armature:

$$O_a = d''_a \times \pi \times \left(l_a + 1\tfrac{3}{4} \times \sqrt{l_h^2 + \left(\frac{d_a''}{8}\right)^2}, \right.$$

or, approximately:—

$$O_a = d''_a \times \pi \times \left(l_a + 1.8 \times l_h \right) \qquad (44)$$

O_a = radiating surface of armature, in square inches;
d''_a = external diameter of armature, in inches;
$= d_a + 2 \times h_a$;
l_a = length of armature body, in inches, formula (12);
l_h = length of armature head, in inches, from formula (43).

(To be continued.)

An English Electrical Invention.

A recent English patent has the following title: "Improvements in Portland cement in union with petroleum; for the incandescence of electric gases; in man's, animals' and birds' excrescences in air, land and water."

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING

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ELECTRO-PHYSICS.

Work of Hertz.—The lecture of Prof. Lodge is continued in the Lond. "Elec.," June 15; a number of interesting experiments are described, and illustrations given. It is written in a rather abbreviated style, and assumes a knowledge of the subject.

Detector of Electric Waves.—In an editorial on Prof. Lodge's lecture, the Lond. "Elec. Rev.," June 15, describes an instrument (illustrated in the Lond. "Elec.," June 15), which he has devised, which is called a coherer; two knobs so close together that the air gap is not able to stand any such voltage as an electroscope can show, will actually cohere when a spark passes between them, and the joint thus completed closes the circuit of an electric bell and battery. On this phenomena he founded a theory of vision, in which the retina of the eye is supposed to be furnished with cohesive contents which allow an electric current to flow in the nerves when acted upon by the electro-magnetic waves of light; mechanical vibration supplied by the tissues restores the sensitiveness of the contact at intervals of a tenth of a second; a model was constructed to illustrate the theory.

Theory of Vision.—See abstract under "Detector of Electric Waves."

UNITS, MEASUREMENTS AND INSTRUMENTS.

Specific Conductivity.—A paper by Mr. Teichmueller, read before the Union of German Electrical Engineers, is published in full in the "Elek. Zeit.," June 9. He discusses the three different ways in which specific conductivity is given, namely by reference to pure copper considered as 100 per cent., by reference to mercury and by representing it in mhos per unit length and cross-section and concludes in favor of the latter; although this method was the one used least, he believes it was due to the want of a name of the unit, which has now been supplied; he concludes in favor of expressing conductivities in mhos and specific conductivites in megamhocentimeters; the number for copper will have values of about 0.58 and 0.595; these values are based on the absolute system but depend on the value of the ohm. The arguments in the article are contained more at length in an article by the same author abstracted in the Digest April 28. He recommends that the society take action by appointing a committee to consider and report on the subject.

Galvanometer.—A paper by Messrs. du Bois & Rubens, describing some new forms of sensitive galvanometers, is published in the "Elek. Zeit.," June 9, including several illustrations and a table of constants.

Photometry.—An article by Mr. Henry on the pupil and photometry is begun in "La Lum. Elec.," June 9, the present portion being devoted to the pupil and its measurements.

Brillie Meter.—A well illustrated description of the improved form of this meter, which is one of the principal meters used in France, is given in "La Lum. Elec.," June 9.

DYNAMOS AND MOTORS.

Current Curves of Alternators.—A paper by Messrs. Roessler & Wedding, read before the Union of German Electrical Engineers, is published in full, together with numerous curves, tables and illustrations in the "Elek. Zeit.," June 9. The object of the paper is to show the influence of the shape of the curves on the candle-power of alternating arc lamps; the second part of the paper, which is devoted to arc lights, is abstracted below under "arc lights." Three machines were tested, the curve of the alternating current being measured by the usual method of making momentary connection between a fixed brush and a movable contact piece which may be placed in any position with respect to the field. The method used is described in detail. Three machines were used, a four-pole Ganz, the armature of which consisted of four radial magnets terminating opposite the pole pieces; a Wechsler, consisting of a sort of a Gramme ging winding, the ring revolving between opposite poles of four pairs of magnets; the third, a machine of Siemens & Halske, in which the armature and field magnet coils were all radial. The results for the Ganz machine showed a very abrupt increase in the voltage, followed by an almost equally abrupt, and an apparently long period of practically no voltage, the latter forming about two-thirds of the whole wave. In the Siemens machine the increase is gradual, the voltage remaining nearly constant for about half the period, and then falls again, including a slight rise just before falling; for the Wechsler machine the curves were between the others and corresponded very closely with a sine curve. A number of conclusions are drawn from these, among which it is claimed that the large air-gap in the Wechsler machine is that to which the approximate sine curve is due, there being no abrupt changes as in the others, and it is concluded that a large air-gap is a very good feature when a sine curve is desired; the flat part of the curve of the Siemens & Halske is due to the very large pole piece, in which it differs from the Ganz machine. Another conclusion is that with alternating current arc lamps, electromotive forces of a different phase than that of the acting voltage do not arise.

Unipolar Dynamos.—The Lond. "Elec. Rev.," June 15, contains an editorial on non-polar dynamos in America, presumably criticising the recent institute paper of Prof. Crocker and Mr. Farnley, in which, however, the main features of the paper are not considered; it is claimed that the suggested designs will be found to be old, and to have been often proposed. Foucault currents are said to exist without doubt, because the armatures of such machines get warm on open circuits; armature reaction takes place to a great extent, as is claimed to have been proven some time ago by direct experiment. It is claimed that the efficiency of the non-polar dynamo and storage battery transformer combination could not possibly be higher than 60 per cent.

ARC AND INCANDESCENT LIGHTS.

Alternating Current Arc Lamps.—A paper by Messrs. Roessler & Wedding, read before the Union of German Electrical Engineers, is published in full in the "Elek. Zeit.," June 9. The first part of the paper treats with the curves of different alternators, and is abstracted under "Dynamos and Motors." The second portion treats of the arc lamp. The influence of the character of the current curves on the regulation of the lamps is discussed; a differential lamp was used, with both shunt and series coils; it was found that the regulation had to be altered very considerably when the lamp was used with three different machines described in the first part of the article, and when continuous currents were used it was not possible to effect a regulation, as the pull and the heating of the coils then became too great. The shunt coil affects the regulation for different curves of current by virtue of its self-induction, and because the pull exerted by these currents will be different, which latter will also be the case with the series coils; it is concluded that if an arc lamp is to be adapted for a number of different machines it is better to use the iron of the coils at as low a saturation as possible. The photometric tests are described in detail, the results being given in tables and curves; the lamp was in each case adjusted so that it would burn with the greatest constancy, when it was found that the maximum variation of the voltage was less than 0.3 volts; the voltages used were between 28.8 and 31.1; the lamps were measured with a white reflector, and the light was measured only below the horizontal plane. When run with the Ganz machine the mean spherical candle-power per watt, below the horizontal, was 0.716; with the Wechsler machine it was 1.03, and with the Siemens & Halske, 1.078; owing to the sudden change in the curves of the Ganz machine the energy was not so well utilized to produce light; by virtue of the gradually changing sine curve the increase in the light for the Wechsler machine was about 44 per cent. or for the same current, voltage and light, three lamps would have to be used with the Ganz machine, and only two with the Wechsler. With the Siemens & Halske an increase of 6 per cent. in the light was obtained, with an increase of 33 per cent. in the frequency. The ratio of the simple mean of the current to the square-root of the mean square is 0.656 with the Ganz machine, 0.907 for the Wechsler, and 0.911 for the Siemens & Halske. For a true sine

curve it would be 0.900; the difference between the first two is about 28 per cent., while the photometric measurements show a difference of 30 per cent., from which it is concluded that the generation of light in the ordinary alternating current arc depends on the mean value of the current as distinguished from the square-root of the mean of the squares. The above ratio will be unity when the curve consists of two rectangles, one above and the other below the line, for which the development of light would then be a maximum, which curve is approached by the Siemens machine; but there are objections to designing machines with such curves; a very loud and disagreeable noise accompanied the running of the lamps with the Ganz machine, while with the Siemens machine this noise ceased, but the humming of the alternating current became greater; but with the Wechsler machine the lamps burned silently. Taking this noise into account, it is concluded that the best ideal is a true sine curve. In conclusion they show that the energy in a continuous current lamp is much greater than in an alternating current lamp for the same current strength. In the former 2.84 mean spherical c. p. were obtained per watt, which was partly due to a very thin carbon, and partly to a greater consumption of energy; with about the same consumption of energy this figure was 2.65, showing that the efficiency in a continuous current lamp is very materially higher; part of the difference is due to the 30 per cent. loss in the reflector. With two continuous current lamps in series on 110 volt mains, 1,528 c. p. were obtained, while with 4 alternating current lamps in series on 110 volts, consuming about the same energy, 1,175 c. p. were obtained, showing that even under these conditions the continuous current arc is the more efficient.

Multiple Filament Lamps.—According to a statement in the Lond. "Elec.," June 15, experiments with these lamps are said to have shown that there is practically no afterglow when the current is shut off, as there is with single filament lamps, and that the English Admiralty have therefore directed that the multiple filament lamp be adopted for mast head flashing lanterns on all the higher class ships.

Life and Efficiency Tests of Incandescent Lamps.—A translation of the article abstracted in the Digest June 9, is published in the Lond. "Elec. Rev.," June 15, giving also the table of results.

ELECTRIC RAILWAYS.

Accumulator Traction.—According to a correspondent in the Lond. "Elec. Rev.," June 15, one ton of batteries of the Theryc-Oblasser type, in a certain trial test ran a car 46.5 miles at 7½ to 9⅓ miles per hour.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Electrical Engineering in England.—A paper by Mr. Kapp, read before the Union of German Electrical Engineers, is published in full in the "Elek. Zeit.," June 5. After discussing the history, the early development and the different conditions in that country and elsewhere, he gives, among others, the following figures. At the present time the number of lamps operated with alternating current, as compared with continuous current, is as 4 to 5; as a mean of 18 continuous current stations he finds that every kilowatt-hour sold per year represents an investment of capital in the installation of about $1.12; a mean for ten alternating current stations gives $1.30; these figures were for the past year, but the stations are not fully loaded; making a correction for an increased number of lamps without increasing the machinery, the figures will be 0.72 and 1.10 respectively; the greater cost of the alternating current station is due to the fact that the distances of the transmission are greater; these figures include all the costs, but for new stations constructed at the present time, and assuming the complete output of lamps, he estimates that the following figures are fair means; for continuous currents $0.62 for the first part of the installation, and $0.50 when the station is completed, and for alternating currents, $0.88 and $0.62 respectively. For an equal amount of light the capital required in the largest gas works is about one-third as great, while for small gas works it is about equal to that for an electrical installation. The average time of lighting of the lamps in the last year was 480 hours. On the basis of 50 watts per lamp there were, during the past year, 825,250 lamps connected to 84 stations, the total power of which was 74,700 indicated h. p.; out of these 467,000 are in England; to light London completely with electric lamps would require from 4 to 5 million lamps, therefore the lighting at present is one-tenth of this. The total capital invested is about 30 million dollars, not including four million invested in the Deptford station; the cost of municipal works per lamp is smaller than that for private companies' plants. The average price charged for the current is about 12 cts. per kilowatt hour, and the average receipt per 50 watt lamp installed per year, is $2.50 to $3. Electricity for electro-chemical purposes is not used much in England; transmissions of power for longer distances is not common, but the application for coal cutting machinery is quite common. He states that, strange to say, the multiphase system is not meeting with favor in England, and many of the companies will have nothing to do with it.

Power Distribution.—In the concluding part of Mr. De Segundo's article, in the Lond. "Elec. Eng.," June 15, he discusses, among other things, the Van Rysselberghe system, to be used in Antwerp (in which power is distributed hydraulically and transformed into electrical energy at small distribution centers), some figures are given, and it is stated that there is no doubt that power can be produced and delivered hydraulically at a smaller cost than electrically, and that the reason is that a more efficient engine can generally be used, and it can be worked more efficiently, as it always works at full load to full stroke, and there is also a much greater efficiency in distribution through pipes. In discussing gas engines he dwells at some length on a combination of electric light and gas interests, which he thinks would solve the problem of electric supply in many cities. He recommends using the gas works as an already constructed power station, and establishing distribution stations at suitable points in the town, where the electric currents are generated by means of gas engines. The following figures are given, taken from the weekly records of a plant at Bradford supplying 300 lamps; the total cost per kilowatt-hour is 4 cts., the price of the gas being about 80 cts. per 1000 cb. ft.; allowing 5 per cent. for loss in mains, and 0.6 cts. per kilowatt-hour for depreciation in plant and buildings, it brings the cost up to 4.8 cts., adding a liberal allowance of 1.2 cts. per kilowatt-hour for management expenses, the total cost will be 6 cts. per kilowatt-hour delivered, which is a lower figure than that usually realized in practice by any purely electric supply company working under those conditions. He discusses the light efficiency of gas burned in a burner, which, according to Prof. Tyndall, is 0.317 per cent., and shows that when used in a gas engine and dynamo, the efficiency is increased 2.5 times, notwithstanding the three-fold transformation. He believes that in a system such as that proposed the cost of maintenance, superintendence and management will be less than under conditons of independent electric supply.

Three-Wire System with a Single Dynamo.—A paper by Mr. von Dolivo Dobrowolski is published in full with illustrations in the "Elek. Zeit.," June 9. He describes his ingenious device (described and illustrated in the Digest, Feb. 3, and referred to May 12), in which the neutral wire is connected to the armature through self-induction coils. In addition to what was given in that abstract, he states that such machines can also be used as motors, and, therefore, as equalizers, in which capacity they may be used to advantage in installations in which it is desired to omit the neutral wire for the more distant districts. The neutral wire of this district is extended only to this motor; with the circuits unequally loaded one-half of the armature acts as a motor and the other as a dynamo. Such a machine will operate only when the difference between the two circuits is not too great in proportion to the output of the dynamo. If the loss of voltage in the dynamo at full load is 4 per cent. the voltages in the halves, when the difference between the two loads is 10 per cent., will be only 0.4 per cent. different from the mean, besides 0.5 per cent. additional in the self-induction coils. It is not possible in this system to increase the voltage on one side, as is possible with two dynamos, but the same result can be accomplished by inserting resistances in the main line to absorb a few volts; or it can be accomplished by inserting a small dynamo in the neutral wire, which will regulate both sides. It need regulate for only half of the difference of potential, and will be sufficient to proportion its wires to carry one-tenth of the current in the outside circuit.

Three-Wire System.—The article by Mr. Claude, abstracted in the Digest June 23, under "Advantages of Constant Voltage," is concluded in "La Lum. Elec.," June 9. He discusses the disadvantages inherent in the three-wire system, concluding that in any case the regulation for constant voltage cannot be accomplished as perfectly as in the simple system. He shows that in case the drop in volts in the neutral wire for the extreme lamp is greater than the loss in one of the outside wires, the apparently paradoxical result may be that the voltage is higher at the extremity of the line than at its origin. He cites another case in which some arc lamps were run between the outside mains, and in which the voltage in one of the circuits suddenly fell to zero, and after a few minutes rose again to its normal value; it was found that one of the brushes of one of the machines did not touch the commutator, which was the cause of the trouble; the total charge had thereby been thrown on the other dynamo, increasing its output to a point beyond the characteristic, thus reducing the voltage to zero, and the arc lights had then only 100 volts, which was not sufficient to start the arcs, but they formed a connection between the outside wires which reversed the faulty dynamo, after which the dynamos were running simply in multiple arc. He calculates that the actual cost of the wire for the two-wire system at 100 volts, is only 25 to 30 per cent. higher than that for three wires, and as the cost of the wires is only about one-fourth of the total cost of the installation, this increase corresponds to only 7 per cent. increase in the total; this, though small, is often considered sufficient to justify the adoption of the three-wire system, notwithstanding the poorer regulation. He suggests using a simple two-wire system at 200 volts, and connecting two lamps in series, believing that the regularity in the voltage will then enable the lamps to be run more brilliant and more economical; also that the output of a station will then probably increase rapidly, as it enables a reduction in the selling price to be made. Such a system is particularly applicable to the alternating current, in which a small self-induction coil can be arranged to be cut into the circuit to replace one of the two lamps in series.

WIRES, WIRING AND CONDUITS.

Safety Fuses.—A paper by Mr. Feldmann, read before the Union of German Electrical Engineers, is published in full in the "Elek Zeit.," June 9. Regarding the safety factor in fuses he states that in America, a factor of 2 is usual, but that it should be different for different kinds of circuits; for overhead wires, for instance, it could very well be 2.5, and even 3, but for underground cables it is much too high for alternating currents, when the current is used for electro-mag-

netic purposes, the fuses should be calculated, not for the working current, but for the total current, including the working and the wattless current, which, in some cases, may be very great; when used only for inductionless apparatus a factor of 2 can be used for secondary circuits, and 2.5 for the primary, it being preferable to have the secondary fuse blow first; when several transformers are used for several consumers, the possibility of short circuits is greater, and he suggests 2.5 for the secondary, and 3 for the primary. When there are a number of large transformers supplying mains in common, the factors should be taken still larger, depending on the equality of the voltage of the different trans formers; the same is true of fuses for dynamos in parallel. Regarding the size of the fuses, he states that the minimum fusing current is proportional to the 3-2 power of the diameter and inversely proportional to the 4th root of the length, and that the size of the radiating surfaces of the clamps affect the fusing current very greatly; in two cases the surfaces, were as 1 to 5, and the fusing currents for otherwise identical conditions were as 1 to 1.35; when one of two like fuses was cooled to 10° C, and another heated to 60° C, the currents were as 1.1 to 1, showing the influence of external temperature. Lead is most unsuitable for such fuses as it oxidizes, the oxides forming an infusible tube. Mr. Preece recommends platinum, which melts like wax, while tin and copper melt with an explosive action; the most common alloy is lead and tin-with or without bismuth and antimony; iron is quite unsuitable; he recommends highly the Schuckert fuses, made of a band cut into a number of thin strips connected at their ends and bent apart so as to allow access of the air; also the Cockburn fuses of tin, with 5 per cent. of phosphor, and a weight suspended from the middle part. These are said to differ in their fusing currents only by 5 to 10 per cent. They are especially to be recommended for small currents, as the wire may be taken slightly larger. The weak point of fuses lies in the poor contacts. Prof. Heim found that the loss of volts due to these contacts varied from 0.06 to 0.4 volts, and for poor contacts these might be much greater. In conclusion he recommends that the Society adopt the uniform practice of marking fuses with their fusing current, and not with a safe carrying current, because the latter differs for different conditions.

Calculation of Mains.—An article by Mr. Frick on a simplified method for calculating the distribution of current in networks of conductors, is begun in the "Zeit. fuer Elek.," May 15. The article does not admit of being abstracted; a table is given serving as a guide for preliminary determinations; it gives the relation between the cross-section of the wire, the load in amperes per metre, considered as being uniform, and the resulting allowable distance between the feeding points for the three-wire system and a maximum loss of 3 volts; the formula for the calculation of this table is given; having made preliminary determinations with the aid of this table, the distribution of the current through the network for a given amount of current may then be determined; he mentions four methods of doing this, one involving equations, which is too complicated, another by means of graphical calculations, another by mechanical devices, and another—presumably his own—which is discussed more in detail; if the distribution of the current thus determined involves more than the maximum allowable loss, the various cross-sections must be modified; the problem is simplified by assuming the potential at the feeding points to be everywhere equal and constant.

Wire Computing.—A correspondent in the Lond. "Elec. Rev.," June 12, recommends the following method as being a quick solution of certain problems.. A table is calculated, giving the cross-sectional area of copper wire for every number of yards per ohm from one to nine; if, for instance, the cross-section of a conductor is required, such that a given number of yards has a certain resistance, dividing the former by the latter gives the number of yards per ohm; if, for instance, this was 526, the cross-sectional area taken from that table for 500 (100 times that for 5) is added to that for 20 (10 times that for 2), and to that for 6, the sum will give the total cross-sectional area. It is suggested that this method of tabulating constants might be extended to other electrical calculations.

ELECTRO-CHEMISTRY.

*Note: Owing to the crowded condition of these columns, articles and notes belonging more properly to the department of Chemistry than to the department of Electricity will hereafter not be introduced in the Digest, unless they are of special interest.**

Waterhouse Electrolytic Meter.—The English journals for June 15 contain an illustrated description of this new and interesting meter; the best description, with the largest number of illustrations, is given in the Lond. "Elec. Rev.," in which the meter is spoken of as "the best of its class yet brought to our notice; . . . . . the curves made out by the inventors are wonderfully straight, and show extreme accuracy throughout the whole range of the meter;" the description in the Lond. "Elec. " is rather brief. A description of the apparatus will be found elsewhere in these columns.

Hermite Process.—A report from the medical journal, "Lancet," is published in part in the Lond. "Elec. Eng.," June 1. Among other things it is stated that the liquid deodorizes but does not destroy organic matter; ordinary paper rapidly reduces the strength of the solution, as does also other materials in the sewers; deodorization is complete only when the chlorinated body is in excess, but in that case it is not admissible to discharge it into rivers; it is stated that the adoption of the Hermite process in towns would no doubt lead to a sanitary condition of things hitherto unreached, but that the cost is excessive; the antiseptic value may be estimated in terms of the available chlorine or oxidizing power, and that, therefore, a solution of bleaching powder of equivalent strength might be substituted for it, and might be much less expensive. The Hermite solution, as an antiseptic, is much more efficient than carbonic acid, even in more dilute solutions, the only other substance which is better, in the latter respect, being corrosive sublimate; the solution seems to be used up and destroyed to a much less extent by organic matter than any other disinfectants which were known to the experimenters; between 0.50 and 0.60 gram of chlorine per litre is all that is considered necessary for sewage treatment.

The report of Dr. Ruffer is summarized in "Ind. and Iron," June 11. The conclusions are that solutions containing less than 0.75 gram per litre are useless for the sterilization of sewage; but with such a solution the sewage can be made quite sterile, provided the solution is intimately mixed; also that the deodorization is immediate. With 250 amperes at six volts, it took 90 to 100 minutes to develop 0.5 gram per litre in a quantity of 750 litres. He finds that in a 0.5 gram solution the amount of chlorine diminished 90 per cent. in 24 hours' standing, but in solutions of 0.75 the loss was only 34 per cent.; when the current is increased 100 per cent. the increase in the yield of the chlorine is only 50 per cent., thus increasing the cost considerably. Experiments are described, showing that in certain cases sterilization was complete, but the action of the air on the liquid after sterilization again contaminates it; the bacillus subtilis seems to be the most resisting. No general conclusions are drawn, except those given above, and the fact that it is essential to disintegrate the sewage and make a thorough mixture with the solution.

The Lond. "Elec. Rev.," June 8, quotes in part the report from the "Lancet," giving, however, some other parts of it; it is claimed in that report that the magnesium compounds play the most important part, which statement is criticised in this journal, and figures are given tending to prove that the sodium chloride plays more than the part of a conductor.

New Accumulator.—Mr. Tauleigne in "Cosmos," June 2, describes an accumulator, the negative electrode of which is formed of carbon in a porous cup, surrounded with chloride of lead firmly packed around it; the positive electrode surrounding the porous cup is also made of carbon, and the electrolyte is a 60 per cent. solution of protochloride of iron; in this condition it is ready to receive a charge; the E. M. F. is 1.40 volts, the capacity per pound of "metal" (as there is no metal, probably the carbon is meant) is 71 ampere hours; the energy stored per pound of "metal" is 75-foot pound hours; a horse-power hour is said to be obtained with about 7.3 pounds of "metal;" he claims to have obtained 23 ampere hours per pound of active material; no gas is disengaged at charging.

Electrolysis.—An article on this subject, elementary in character, is published in the Lond. 'Elec.," June 15, by Mr. Waddell; some interesting analogies are given.

Electrolytic Gold Leaf.—Mr. Swan, before the Royal Society of London, exhibited several specimens of electro-deposited gold leaf four millionths of an inch thick; the gold is deposited on a thin, highly polished electro-deposited sheet of copper, which is then dissolved off with per chloride of iron; it reflects like a yellow mirror, and is perfectly transparent, transmitting a greenish light.

Electrolytic Iron.—According to the Lond. "Elec. Rev.," June 15, Mr. Lockyer finds from the spectrum of electrolytic iron that it contains calcium and manganese, as well as traces of other metals.

MISCELLANEOUS.

Retort Carbons.—In a report to the German Gas Society, Mr. Hempel calls attention to the high price of large retort carbons as used in electrolytic processes, and suggests that it might be possible to manufacture such plates in the retorts themselves, by supplying smooth flat surfaces on which the carbon is deposited; it might be possible to introduce the contact wires in the plates during the process of their formation.

Death by Electricity—Dr. d' Arsonval, in a communication to the Paris Academy of Sciences, states that death from the electric current is like that in drowning, and is often only apparent; in such cases the treatment should, therefore, be like in cases of drowning; he believes that the criminals executed electrically in New York are really alive, and die only in the absence of restoratives. He cites the case of a workman in St. Denis who was subjected to 4,500 volts, and was restored to consciousness in a short time, although he had been left three-quarters of an hour under the supposition that he was dead. He was restored by artificial respiration.

Bacteriology.—According to a note in "Cosmos," June 2, Prof. Ward, in a Royal Institute paper, shows that light rays and not heat rays are what kill bacteria; also that among the different colored rays the blue are the most effective.

Saturn's Rings.—A note in "La Nature," May 19, discusses the possibility of the maintenance of these rings by the magnetic action of that planet, supposing that the rings are composed partly of a dia-magnetic substance; it is thought possible that the magnetic field of that planet is 100 times as great as that of the earth.

* The attention of electro-chemists is called to the "Elektro Chemische Zeitschrift" in the German language), which we believe is the only journal devoted exclusively to the subject of electro-chemistry; each number, besides containing original articles, includes also a digest of the principal articles on electro-chemistry published in other journals. It was started in April of this year and is published monthly by Dr. N. von Klobukow, in Berlin, Koethener St., No. 44. The subscription price in this country is 18.40 marks, or about $4.50.

New Books.

THE PRINCIPLES OF ELLIPTIC AND HYPERBOLIC ANALYSIS. By Alexander Macfarlane, M.A., D. Sc., LL.D. Boston: J. S. Cushing & Co. 47 pages, 15 diagrams. Paper. Price 50 cents.

This pamphlet, like the one by the same author "On the Definitions of the Trigonometric Functions," already reviewed in these columns, is a reprint of a paper read before the Mathematical Congress at Chicago, Aug. 24, 1893, with the addition of new matter relating to the trigonometry of the general ellipsoid and hyperboloid. The work is another contribution to the system of vector analysis developed by the author, being the fifth publication on the subject. The part of the subject here treated is the extension of the versor analysis from the simpler cases pertaining to the circle, equilateral hyperbola and logarithmic curve, which were treated in the preceding papers, to the more complex cases involved in the geometry of the sphere, the general ellipsoid and the general hyperboloid.

The author aims to construct a system to take the place of the Hamiltonian quaternious, to be at once simpler (that is, less inscrutable) and more rational and logically consistent with the rest of mathematics. In this we are inclined to think he has succeeded (although it must not be thought that his method can be mastered without patient study), and he certainly shows power as an original and independent thinker.

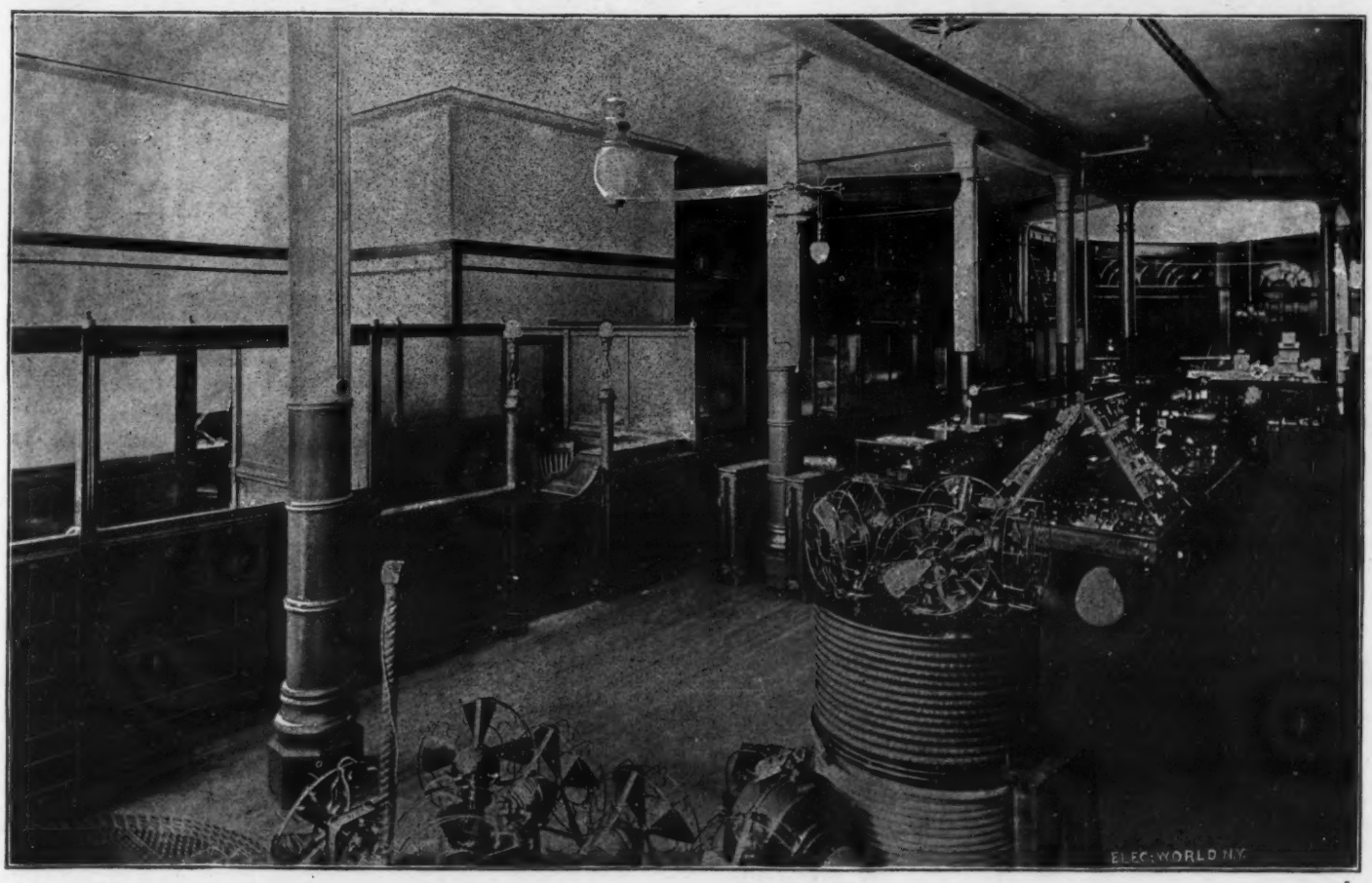
NOTES.

We have received a pamphlet entitled "The Coming Railroad; the Chase-Kirchner Aerodromic System of Transportation," which describes a system of transportation denoted as a "compromise between the present railroad and aerial navigation." One of the inventors is Lieut. George N. Chase, of the United States Army.

The system consists of an elevated iron structure with four girder rails and two trolley conductors for a single-track road. The driving wheels with direct connected electric motors, run upon the upper girder rails, while idle wheels are arranged beneath the lower girder rail, and controlled by compressed air for use in case of necessity to prevent derailment and also to brake the car by throwing the wheels into contact with the rails, and at the same time into contact with a brakeshoe on the car body. The projectors undertake the construction of a car which will be able to "run upon the air" at great speed, guided by a track and supplied by electric power from central stations. For this purpose they have sets or banks of adjustable aeroplanes, the area of which may vary for different kinds of cars, from 2,000 to 4,000 square feet; the adjustment of their pitch is regulated by the engineer in charge. It is proposed to introduce grades when necessary to avoid lateral curves and utilize the planes for assisting them over grades by lifting the cars to the extent of the lift of the aeroplanes. They argue that if on a grade the maximum lift for a level can be maintained by calling into action a reserve of power (the planes) the weight so compensated for may be left out of further consideration, and "if the grade should be too steep for the remnant of the weight to preserve the requisite traction, sufficient artificial friction can be generated by the air pumps and friction wheel beneath the car."

As the driving wheels, however, run upon the upper rails, it is not made clear how any driver beneath the car will maintain the requisite traction when the planes lift the car or even tend to lift it. It is well known to locomotive engineers that the higher the speed the greater must be the traction. There is a disclaimer to any advantage of the aeroplanes for straight roads, in which case thesystem would be an electric elevated railroad, using four rails instead of the ordinary two. The pamphlet is interesting for the statistical railroad data and atmospheric resistance tables which it gives, as well as for its discussions of the principle laid down by Langley, Maxim and others in relation to aeroplanes.—(St. Louis, Mo.)

The Proceedings of the Electrical Society of Cornell University for 1894 contain a number of papers on various electrical subjects, most of which are resumes or reviews, and apparently represent studies supplementary to the college text book course. The titles are as follows: "Lead Secondary Batteries," "The Counter Electromotive Force of the Voltaic Arc," "The Design and Construction of Power Stations," "Power Station Switchboards," "Feeder Systems," "The Development of the Incandescent Lamp," "High Speed Electric Railroading," "Notes on Some of the Work of Nikola Tesla," "The Tesla High Frequency Phenomena," "Long Distance Transmission of Power." In almost all of the papers the subject is historically treated, and in many references are made to various sources of information, in most cases authoritative ones. The present brochure is the first issued by the Electrical Society, which was organized on Nov. 20, 1893, and whose meetings for the reading of papers and discussion of live topics are held semi-monthly. This first volume of its publications gives promise that the society will fulfill the hope of its founders, if indeed it does not already do so, of ranking "among the foremost engineering societies in American universities."—(Ithaca, N. Y.)



New Home of the Central Electric Company.—Bookkeeping Department.

The New Home of the Central Electric Company.

The history of every successful concern is one of change, a gradual evolution from small beginnings to the greater proportions which maturity and prosperity bring. With the growth of business there comes the necessity for more convenient and commodious quarters. Starting with very humble accommodations, the successful company soon finds itself in a comfortable home. The well-known supply house, the Central Electric Company, of Chicago, affords a good illustration of this. The company has not only moved once, but thrice. At the time of its organization in 1887 it occupied small salesrooms on the second floor

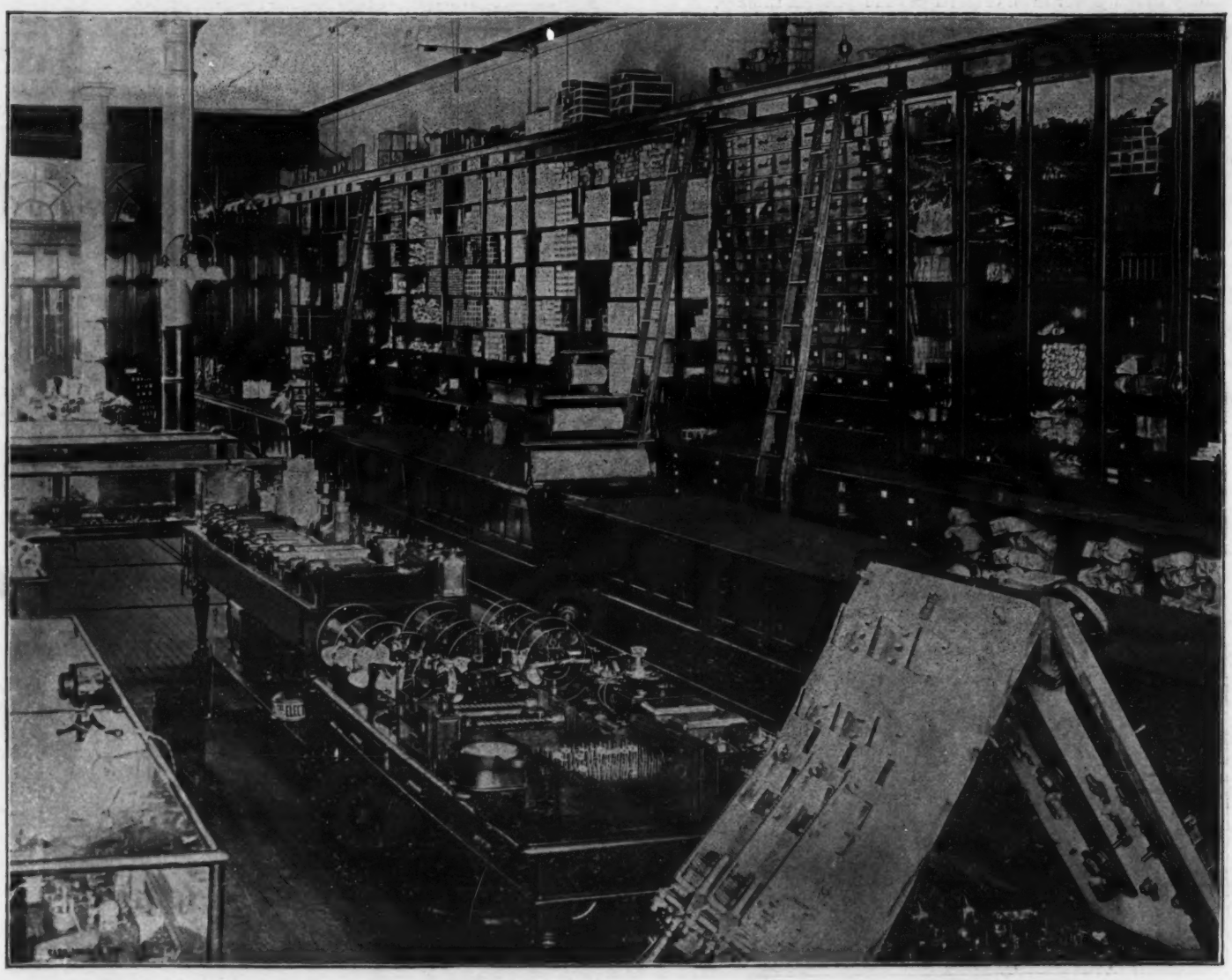
at 38 and 40 La Salle street. The following year it moved only a short distance to 42 La Salle street, where it found more comfortable accommodations. Two years later, however, these were found inadequate, and in January, 1890, the company again moved, this time to locate at 116 and 118 Franklin street, which soon became a well-known center for electrical supplies. The rapid growth of the business, however, soon demanded another change. The company desired this time to choose a site that might serve as a more permanent home, and after careful consideration, located at 173 and 175 Adams street. The Edison General Electric Co., and later the General Electric Company, formerly occupied this building. The Central Electric Company took possession in April last, after the building had been somewhat remodelled, and placed in good condition for its occupation. The location is a fine one, being accessible to the various depots and freight houses, and to the different cable lines, and situated in the central part of the business portion of the city.

On the spacious ground floor of the building the offices, salesrooms and shipping department of the company are located. To the left of the main entrance are the offices, while the sales offices are on the right. Room has been provided for the display of many of the finer grades of goods in show cases, and on sample tables. Sample fixtures of various kinds will be shown in a room which is being fitted up for that purpose for a fixture department. The rear of the main floor is occupied by the shipping department, and an alley at the back of the building makes it convenient for loading and unloading trucks. The elevator is so situated that goods from the different floors may be loaded directly from the elevator to the truck. The president's office is readily accessible, but at the same time, of course, has the desired privacy.

The various departments are each in charge of an experienced salesman, who is able to furnish information to customers in regard to his own department, and who is familiar with the methods of manufacture and the condition of trade in his particular line.

W. H. Huddlestone is in charge of the motor department, the company being the agents for the well-known Lundell motor. The house goods department, including hotel and office electrical goods, is in charge of W. R. Pinckard. A complete line of annunciators, bells, batteries, etc., are included among the stock of this company. Special facilities are provided whereby the shipment of goods is easy and rapid. Okonite wire is one of the commodities for which the company is widely known. Interior conduit is also one of the staple articles, and special provision has been made to illustrate this method of wiring by a sample installation on the main floor.

To the efforts of George A. McKinlock, the energetic president and general manager, the success of the company is in no small measure due. Mr. Charles E. Brown is the secretary of the company, and has been connected with it for several years. The staff throughout is an able and efficient one.

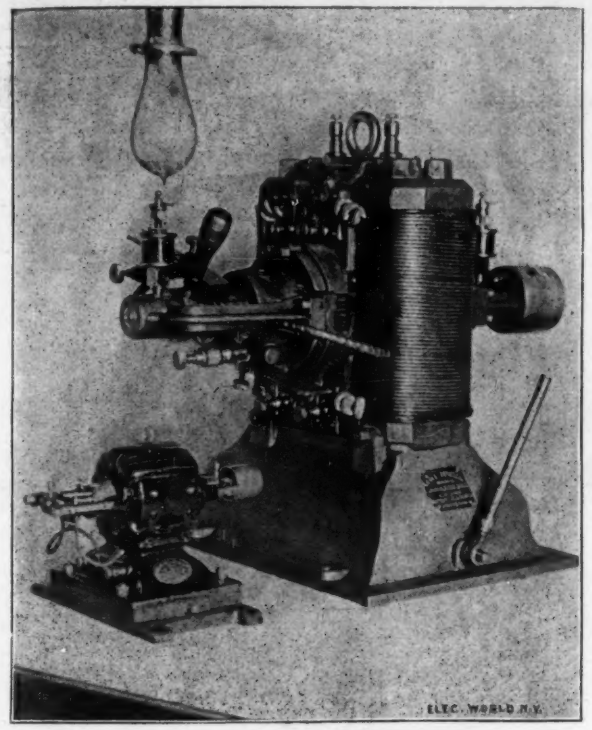


New Home of the Central Electric Company.—Retail Department.

An Amateur's Practical Work.

The result of a beginner's effort, is illustrated in a complete little electric lighting plant, designed, constructed and installed, unassisted, by Mr. G. E. Dunton, of Augusta, Maine. The accompanying illustrations are taken direct from photographs of the machines and switchboard. Becoming interested in the elementary principles of applied electricity, Mr. Dunton naturally read and studied such literature treating this subject as came within his grasp, with a result that he has, with a small lathe and a few tools, constructed the apparatus shown herewith. The dynamo is of the two-pole, double-magnet type, with a series wound field, and cores eight inches long. The capacity is 20 amperes, at 55 volts. The weight of the dynamo complete is 156 pounds, giving an electrical efficiency of 6.41 watts per pound of metal used in construction. The total height is 18 inches from floor to top of eye-bolt, and the space occupied by the base 10 by 15 inches. The little motor on 55 volts, and from nine-tenths to two and one-half amperes, develops over one-eighth of a commercial horse-power, and has driven two sewing machines, a large planing machine, and a thirty-six inch grindstone, for business, starting each from a standstill. It will drive a twelve-inch, six-bladed ventilating fan, placed directly on the shaft, in place of the pulley, at 3,500 revolutions per minute. It is compound wound, of the two-pole, double-magnet type, the core being made from a piece of two and one-half inch, ordinary steam pipe, two and one-half inches

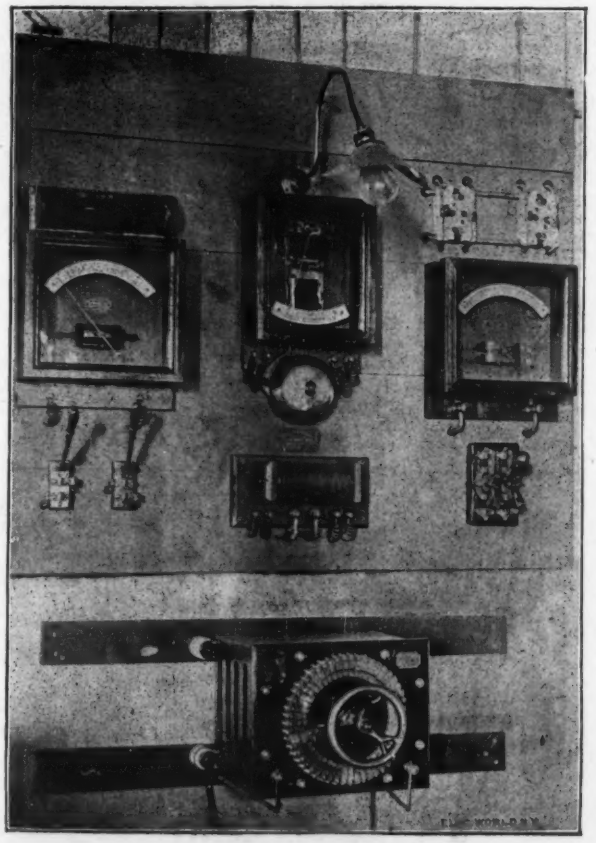
long. The total height is five and three quarters inches from the bottom of the base to the top of the eye-bolt. The base occupies a floor space



AMATEUR DYNAMO AND MOTOR.

of four and one-half by five and three-quarters inches. The motor weighs, complete, nine and three quarters pounds.

The simplicity of construction, positive action and sensitive balance



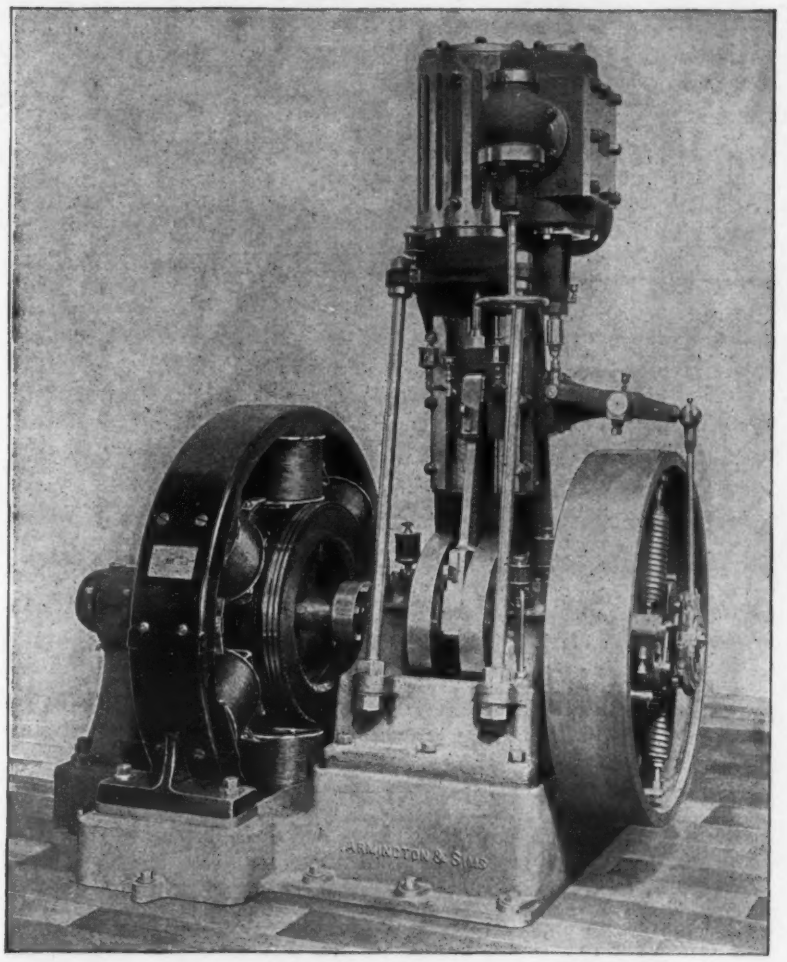
AMATEUR SWITCHBOARD AND INSTRUMENTS.

are marked features of the instruments, and highly creditable. The volt-meter (at the left, on the switchboard) has a range of from 0 to 60 volts. The meter, on the extreme right, as adjusted, has a capacity of 60 amperes. Both these instruments have direct reading scales, and are positively dead beat in action, no springs or gears being used in their movements. The circuit tell-tale, or alarm indicator(in the center) will automatically ring a continuous alarm upon any unusual interruption of the current in the circuit. The bell is rung moderately on an open circuit, but violently upon too much current or a short circuit, and will continue ringing until relieved or switched out. The adjustment is for 20 incandescent lamps; should one more be turned on, the alarm will sound. The movement of this instrument is so sensitive in adjustment that when the arc lights are thrown into circuit, the pointer will show the least variation in the arc, hardly perceptible to the eye. The pointers in these instruments are hung on pivoted balances. The scales are of white enamel on copper. The switches are laid on slate bases, and their alignment is good. The double-throw is of original design, called the "quick-lightning." The rheostat is in a fire-proof, iron and slate box. It contains about 810 feet, No. 16 iron wire, divided into 100 coils. The segments to which the coils connect are all "cold-chiselled" out from three-sixteenths sheet copper and filled up.

Mr. Dunton in all his construction has displayed much ingenuity; without any instruction or previous experience, he drew his own plans, made all patterns required for castings used, shaped and fitted all parts (as far as machinery at his disposal would permit), and did all his winding unaided.

A Compact Plant.

The accompanying illustration shows one of the four compact plants which the General Electric Company has recently installed in the Man-



A COMPACT PLANT.

hattan Life Insurance Building, New York. It consists of a six-pole, 25-kilowatt, 300-revolution iron-clad generator, connected to the shaft of an Armington & Sims vertical 40-h.p., 9½ x 10 inch engine. The other three consist of 50-K.W. generators, and 30-h.p. engines.

These small direct connected generating sets are now being built in large numbers by the General Electric Company at its Schenectady works, the demand for them having become very urgent. They occupy but comparatively little space, and this feature alone would recommend them highly for all isolated plant or marine work; they are solidly and substantially reliable, and wherever they have been installed have given perfect satisfaction.

Electric Alarm and Pressure Gage.

The object of the invention we illustrate, manufactured by The E. G. Bernard Company, Troy, N. Y., is to provide an electric alarm signal or high or low pressure that can be atached to all forms of pressure gages. At the same time, it is provided with a simple means of testing the gage and signal apparatus to see if they are in working condition at all times.

Fig. 1 is a view of the face of a common form of a pressure gage provided with the alarm attachment. The small lever or finger to the right, if pressed either up or down, will test the gage in either direction for

Fig. 1.—Alarm and Pressure Gage.

high or low alarms, thus showing that both the gage spring and the electric signal apparatus are in perfect order. The value of this attachment is obvious, as any device of this kind, which cannot be easily and

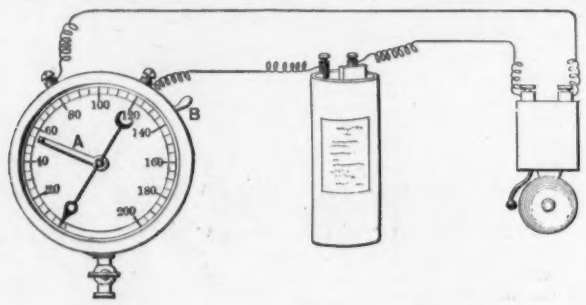


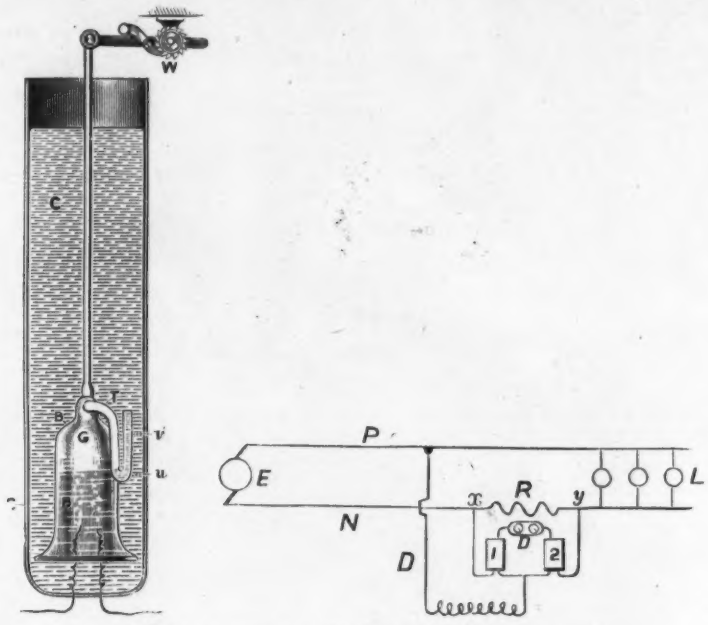
Fig. 2.—Diagram of Connections.

constantly tested is always held in distrust on account of actually increasing instead of diminishing danger.

Fig. 2 is a diagram of connections, which makes evident the simplicity of the system. Besides its use on steam boilers the gage is peculiarly adapted for both wet and dry sprinkler systems, both to indicate if the apparatus is in working order and give an alarm in case of leaks.

The Waterhouse Electrolytic Meter.

The principle of the Waterhouse electrolytic meter, which has recently been brought out, is shown in the accompanying illustrations, Figs. 1 and 2. Electrolysis of a 12 per cent. solution of sulphuric acid takes place beneath a suspended glass bell jar, having a siphon attached to the top as shown; as the gases are collected the bell jar rises, and when the quantity of gas is sufficient to force the liquid out of the siphon tube, the gases will discharge themselves through this tube, the bell jar will sink, and in doing so will register on a suitable integrating device, which will, therefore, register the number of times that the gas collector has been filled and emptied. As the loss of voltage in the meter is limited to 0.5 volts, which is too little for electrolysis, the current for producing electrolysis in the meter is taken from the positive main, as shown in Fig. 2, passes through a resistance of 1,200 ohms, then divides, passing through two of these electrolytic measuring devices 1 and 2, and thence to the points, x, and, y, at the extremities of the resistance R. through which the main current to be measured passes, the maximum difference of potential between x and y being 0.5 volts; the meters 1 and 2 operate differentially, only their difference being registered; when no current is required for the lamps, the same current will pass through the two meters, and nothing will be registered, but when a current passes through R to the lamps, a difference of potential will be produced between, x, and, y, which will cause one meter to register more than the other, the difference, which is shown on the dial, being then a measure of the current in the main circuit. By this device any effect due to changes of resistance caused by heat, or change in the specific density of the liquid, are counteracted, and thereby some of the chief difficulties of electrolytic meters are overcome; owing to the differential action, extreme sensitiveness is obtained, besides a great range; it is free from complications of resistances or parts requiring careful measurements; is easy to calibrate and cheap to construct. A change in the voltage of the mains does not materially affect the meter, owing to the differential action of the two cells; a special device is added which cuts off the shunt current when all the lamps are turned out, and starts it again as soon as one of the lamps is turned on; only pure water is used in refilling the cells, and this is required only once every three months. Several other arrangements differing in the connections



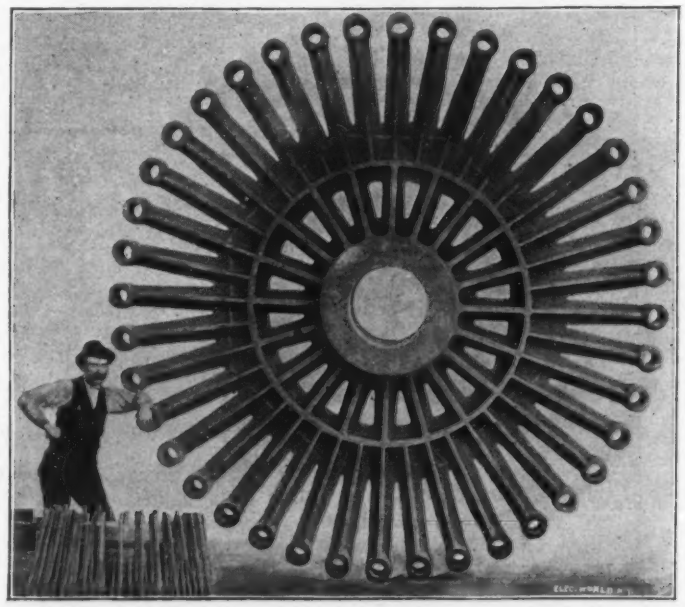
Figs. 1 and 2.—Electrolytic Meter.

between the cells and the mains are described and illustrated in the foreign journals, but the form shown in Fig. 2 herewith is the one which will probably be adopted, as it has very important advantages over the others. It is also proposed to apply this voltameter principle for producing non-wasteful shunts, safety shunts for series motors run at constant current circuits, etc.

A Mammoth Armature Star.

In the accompanying illustration is shown one of a pair of probably the largest armature stars or carriers in the world. A pair of them have recently been made by the Wells & French Company, for the Siemens & Halske Electric Company, of America, who will install them at Toronto, Ontario, for street railway service.

The machines when completed will weigh about 60 tons each, and have a nominal capacity of 1200 kw. or 1600 electrical h. p. each, under



A Large Armature Star.

500 volts pressure, and will be over-compounded for 12 per cent. drop in the lines. They are to be directly connected to a pair of horizontal cross compound condensing engines making 80 turns per minute.

The armature stars are 13 feet in diameter, and weigh something over 10 tons each. The brush carriers will be about 14 feet 6 inches in diameter, being made by the same concern. The castings came from the mould absolutely perfect, without a warp, crack, flaw or blow hole, and are now being finished for the armature.

FINANCIAL INTELLIGENCE.

THE ELECTRICAL STOCK MARKET.

New York, June 30, 1894.

THE ELECTRICAL STOCK MARKET, in common with all speculative markets, is apparently awaiting the distribution of the large dividend and interest payments on July 1, before developing any decided turn to quotations. Just at present there is no appreciable outside interest to speculation, but it is argued that a new impetus must be given to all kinds of securities by the endeavor to place the large July disbursements—New York, Boston, Philadelphia and Chicago are expected to pay out on that date something like $125,000,000—renumeratively, and, while traders are disposed to feel bearish on one or two securities, the odds just now are all against any continued bear campaign.

AMERICAN BELL TELEPHONE has furnished the chief topic of gossip and thought in financial electric circles, by reason of the veto by Governor Greenhalge, of Massachusetts, of the bill permitting the company to increase its capital stock to $50,000,000, and the refusal of the Massachusetts Legislature to pass the bill over the veto. The Governor's action was, to put it mildly, unexpected. To the friends of the Bell Company the veto came like a thunderbolt from a clear sky, as it was thought that, after the approval given by the Legislature to the matter, the Governor would not block the way. Speculative sentiment condemns the Governor; naturally so, as it effectually wipes out a good many "plums," long and fondly anticipated. Public sentiment on the matter is divided, though there is a general disposition to regard the veto as a wholesome check to a species of legislation hardly in accord with the safest and most conservative modern ideas. The effort to secure the legislation to allow it to issue some $30,000,000 new stock to stockholders, at par, has cost the American Bell Telephone Company a pretty penny. It is current gossip that $250,000 were expended in lobbying and other necessary means of "expediting" legislation. This is now all clear loss. On the day when the Governor's veto was made public the stock closed at 202. On Wednesday morning it opened at 190, a loss over night of 12 points. It went down further to 188, but recovered later on, and is now 195, a net loss for the week of 7 points. There is no real reason why the stock should sell much lower. It can still earn and pay 3 per cent. quarterly, although business just now is not over good. This is proved by the statement of instrument output for the month ending June 20, which shows: Gross output, 9,126; returned, 6,316; net, 2,810: a decrease of 1,668. Since December 20, the record for six months shows: Gross output, 41,025; decrease, 11,324; returned 34,695; increase, 6,761; net output, 6,330; decrease, 18,085.

GENERAL ELECTRIC, though not very prominent in the tradings, has been strong at odd times during the week on covering of short contracts. The bears have become disgusted with their inability to create a serious depression in the stock's price, and have determined to close out their contracts. This has lead to some buying, enough at all odds to lend a species of firmness to quotations. People who are bullish on the stock say that, when the whole stock market turns, General Electric will be one of the leaders. They point to its increasing business; the contract to equip the Chicago Metropolitan Elevated Railroad being particularly profitable, and general trade, especially the item for supplies and renewals to subordinate companies, being also very good. With every note paid and with $600,000 cash on hand, the General Electric Company has assumed an unusually strong financial position, and is now able to take advantage of every favorable opportunity in the electrical trade that may present itself. Apropos of the recent sharp advance noted in the stock, a pretty piece of gossip comes from Boston. It is asserted that the little boom was largely due to buying for the account of people who had the tip that some sort of an alliance with the Westinghouse Company was shaping. As the story goes, they held patiently on to their purchases, awaiting developments; but, as these did not materialize, and as the officials on both sides hastened to deny the existence of any negotiations looking to any such consolidation, the people who had loaded up unloaded again and at a loss. And now there are some people down East who are very sore and whose belief in the value of "outside tips" has been rudely shaken. No importance is attached here to the receivership of the Western Electric Company, as all it owed to the General Electric Company was well secured.

WESTINGHOUSE ELECTRIC common stockholders continue to be regaled, as a sort of antidote for their disappointment at not receiving this time the long expected quarterly dividend with stories of big business and prosperity. Last month's manufacturing output is stated to foot up about $550,000, with orders received for about the same amount of new apparatus. From headquarters comes confirmation of the statement made in these columns two weeks ago, that an active campaign was contemplated in the local electric lighting field in New York city. The district is to be flooded with the new lamps now being turned out at Brinton at the rate of 4,000 a day by reason of the success of the new glass works. The lamps will be offered at 25 cents to users of Westinghouse apparatus, with a discount of 20 per cent. for large lots, the value of the return bulb being placed at 4 cents, instead of 10 cents. When the new factory is in complete operation by October 1, next, it will have a capacity of 30,000 lamps. There have just been bought at Brinton 14 more acres of land, making 37 acres for the new works, and everything will be complete by the date specified. The pay roll of the company is said to show a continuous increase.

FT. WAYNE ELECTRIC matters still occupy some prominence, though there is absolutely nothing doing in the stock. It is charged that the old company has not, as asserted, sold out to the Ft. Wayne Electric corporation, and some interesting developments are awaited when one or two opposing stockholders will take the whole matter to the courts for ventilation.

THE STREET RAILWAY & ILLUMINATING PROPERTIES have purchased another 507 shares of preferred stock at an average price of 98.6 per cent., and are in the market for more.

WESTERN UNION TELEGRAPH is absolutely featureless, though there are rumors of a bull pool being formed to lift the stock at an early date into activity and higher prices.

THE INTERIOR CONDUIT AND INSULATION CO. have declared a 5 per cent. scrip dividend, which is convertible into fully paid capital stock. The transfer books will be closed at 3 p. m. July 16, and the dividend will be paid August 1, 1894. This is the first dividend of the company, and it is somewhat of a surprise to the stockholders. The company has been doing an excellent business in fan motors and other of its specialties, so that it was supposed a good cash dividend would be declared. The sales on one day last week, for instance, amounted to 345 fan motors, and in addition 30 motors of a large size. The directors say that while the company has earned enough to pay about 10 per cent., it is considered best to use the money in the business and in accumulating a surplus.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Cleveland General Electric Co.	100	80	90
Detroit Electrical Works	10	3	4
East River Electric Light Co.	100	—	50
* Edison Electric Ill., New York	100	99	100
* " " " Brooklyn	100	101	102
" " " Boston	100	116	115
" " " Chicago	100	135	145
* " " " Philadelphia	100	128	130
Edison Electric Light of Europe	100	1	3
Edison Ore Milling	100	10	15
Electric Construction & Supply Co., com	15	15	17⅛
" " " " " pref.	15	15	17½
Fort Wayne Electric	100	1	2
General Electric	100	36	36⅛
Interior Conduit & Ins. Co.	100	45	55
Mount Morris Electric	100	25	50
Westinghouse Consolidated, com.	50	35	36
" " pref.	50	50⅛	51⅛

BONDS.

Edison Electric Ill., New York	1,000	106¼	107
Edison Electric Light of Europe	194	75	85
General Electric Co., deb. 5's	1,000	86¼	86¾

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	195	196
American District Telegraph	100	—	45
American Telegraph & Cable	100	88	89
Central & South American Telegraph	100	105	110
Commercial Cables	100	125	—
Gold & Stock Telegraph	100	102	104
* Mexican Telegraph	100	190	200
* Western Union Telegraph	100	83 4	83⅝

* Ex. div.

NEW INCORPORATIONS,

THE DRAWBAUGH TELEPHONE COMPANY, Boston, Mass., capital stock $10,000,000, has been incorporated.

THE NORTH JERSEY STREET RAILWAY COMPANY, Newark, N. J., capital stock $5,000,000, has been incorporated.

THE OHIO HARRISON TELEPHONE CONSTRUCTION COMPANY, Norwalk, O., capital stock $20,000, has been incorporated.

THE ELECTRIC MEDICAL ASSOCIATION OF WEST VIRGINIA, Wheeling, W. Va., has been incorporated with a capital stock of $5,000.

THE CORAOPOLIS ELECTRIC LIGHT COMPANY, Coraopolis, Pa., capital stock $5,000, has been incorporated by W. H. Guy and others.

THE ROGERS PARK LIGHTING COMPANY, Chicago, Ill., capital stock $30,000, has been incorporated by Henry Heistand and others.

THE PHILADELPHIA & TRENTON STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock $150,000, has been incorporated.

THE ELECTRIC FIRE PROOFING COMPANY, New York, capital stock $150,000, has been incorporated by Edwin A. Bradley and others.

THE COVER CURRENT MOTOR COMPANY, Everett, Wash., capital stock $100,000, has been incorporated by John M. Cover and M. O. Tibbits.

THE ECONOMIC ENGINE COMPANY, Chicago, Ill., capital stock $100,000, has been incorporated to manufacture electric motors and engines, etc.

THE ROXBOROUGH, CHESTNUT HILL & NORRISTOWN TRACTION COMPANY, Philadelphia, has been incorporated with a capital stock of $5,000.

THE MICHIGAN HARRISON TELEPHONE CONSTRUCTION COMPANY, Grand Rapids, Mich., has been incorporated with a capital stock of $50,000.

THE INFINITY MANUFACTURING COMPANY, New York, capital stock $4,000, has been formed to manufacture dry batteries. J. J. Solomon, 59 East 111th street, Davis B. Hart, 146 West 48th street, and J. I. Hart, 47 West 56th street, New York, are the promoters.

THE CLEVELAND & ELYRIA RAILWAY COMPANY, Cleveland, O., capital stock $100,000, has been formed to build and operate a street railway to be operated by electric or other motive power, etc. B. F. Phinney, Jay Comstock, H. D. Coffinberry, J. M. Gasser and Dallas Beebe are the organizers.

KANSAS CITY ELECTRIC STREET RAILWAY COMPANY, Kansas City, Kan., capital stock $1,000,000, has been formed to construct and operate a street railway. E. L. Luggren, Benj. Jones, Ozone Park, N. J.; F. B. Wilcox, Kansas City, Mo.; L. Hummel, West Chester, Pa.; J. F. Parrott, R. A. Kope and P. F. Spickler, of Kansas City, Kan., are interested.

THE LEAVENWORTH ELECTRIC RAILROAD COMPANY, Leavenworth, Kan., capital stock $300,000, has been formed to construct and operate a railroad by steam, electricity, or other motive power; also telegraph and telephone lines. The promoters are W. D. Bethel, Memphis, Tenn.; N. H. Smith, Boston, Mass., and Newman Erb, New York.

SPECIAL CORRESPONDENCE.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, July 2, 1894.

NIKOLA TESLA has received the degree of M. A. from Yale College.

THE RUGGLES-COLES ENGINEERING COMPANY, 29 Cortlandt street, agents for the Pittsburg Gage Co., is meeting with very gratifying success with water columns and gage cocks, especially for use in electric light plants.

L. AUERBACHER, of the Automatic Electrical Speciality Company, 136 Liberty street, New York, has recently been appointed agent for the sale of the New Beacon lamp. Mr. Auerbacher reports business exceedingly good in all his specialties.

H. G. ISSERTEL, late manager of the street railway department of the A. B. C. Company, has accepted a position with the H. W. Johns Manufacturing

Company. Mr. Issertel's thorough knowledge of the street railway and general electrical trades will have through this connection a fine field for its exercise.

T. J. MURPHY & CO., 136 Liberty street, have recently made an addition to its factory, 810 Greenwich street, this city, where the company will keep a large stock of slate and marble constantly on hand, which can be cut to the required size. This new departure has been made in order to provide for its customers who may not be able to wait long enough to get what they require from the quarry.

MR. THOS. A. EDISON met with a severe accident last week which, though causing considerable suffering, fortunately entailed no serious consequences. While sitting on a porch the hind legs of his chair slipped over the edge, throwing Mr. Edison backward to the ground several feet below. Owing to his weight the fall might have been fatal, and at one time it was thought that some internal injury had been received; after several days' confinement to his room, however, Mr. Edison is rapidly convalescing.

New England Notes.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., June 30, 1894.

THE PETTINGELL-ANDREWS COMPANY, Boston, Mass., have recently added to their varied list of specialties those of the Billings & Spencer Co., of Hartford, Conn., for the Eastern district, and have already secured several very large orders for the well-known commutator bars manufactured by this company. General Manager Price reports business generally as being unusually good. The motor department is making an extraordinarily good showing, and so is the railway department, quite a number of good-sized contracts for overhead equipments having been booked recently.

Canadian Notes.

Ottawa, June 30.

ST. JOHN, N. B.—The St. John Electric Street Railway has elected the following directors: Sir Wm. Van Horne, president; James Ross, J. J. Tucker, H. P. Timmerman and H. H. McLean.

HAMILTON.—At a meeting of the directors of the Hamilton Street Car Company it was decided to try the experiment of a limited Sunday car service. For a few Sundays about half the regular number of cars will be run from 10 to 1, from 2 to 5, and from 6 to 10.

OTTAWA, ONT.—At a meeting of the Railway Committee of the Dominion Parliament, an act to incorporate the New York, New England & Canada Company was adopted. The preamble of the bill to incorporate the Boynton Bicycle Electric Railway Company, projected to run from Winnipeg to Louisburg, Cape Breton, was adopted. The further consideration of the bill was adjourned until the promoter was able to give fuller information.

OTTAWA, ONT.—Letters patent have been issued to Messrs. David Maclaren, of Ottawa, lumber merchant; Alexander Maclaren, of Buckingham, lumber merchant, as the Gibbs-Franchot-Maclaren Company, the works to be on the Lievre River, to manufacture and produce chlorates, acids, alkalis and other things. Their charter gives them power to operate mines, electric light and to manufacture packages and keys, the capital stock to be $50,000.

OTTAWA, ONT.—A meeting of the directors of the Chaudiere Electric Light Company was held in the office of Messrs. Ahearn & Soper, Monday evening. A dividend of 8 per cent. was declared, payable on July 1. The annual report showed that there were 26,000 lights in operation, and that 8,000 had been installed during the year. The board was re-elected as follows: G. P. Brophy W. Y. Soper, J. W. McRae, T. Ahearn, T. Workman, Robert Hurdman, W. G. Hurdman, William Scott and William Hutcheson.

English Notes.

(From our own Correspondent.)

London, June 20, 1894.

ELECTRIC RAILWAYS IN LONDON.—Work on the electric railway, which will run from Waterloo under the Thames into the city, has been commenced.

ELECTRIC RAILWAY ENTERPRISE IN LONDON.—As I foreshadowed in a recent letter, the London County Council has succeeded in killing yet another scheme. By its injudicious insistance upon the insertion of onerous clauses in the bills of several schemes, they have already succeeded in maintaining the majority of these projects in a state of suspended animation. The British public is long-suffering, but it has not yet been disciplined into gratuitously providing money for the comfortable carriage of the British workman from his suburban residence to his daily labors.

ELECTRIC LIGHTHOUSES.—Another instance of the failure of the electric light to pierce a fog was recorded at a recent Board of Trade inquiry into the wreck of the steamship Jasper. This vessel was carried out of her course in a dense fog, and struck the rocks within 500 yards of the May Island electric light; the glare of the light being only noticed two minutes before the vessel struck. The May Island light was erected about eight years ago, and in clear weather can be seen for a distance of 20 miles. A sailor who gave evidence at the inquiry stated that on a previous occasion, when he was about a mile off the island, he could not see the electric light, although he could see the oil light on the Fifeshire coast, 2½ miles off.

NEWS OF THE WEEK.

Telegraph and Telephone.

PITTSBURGH, PA.—The American Telephone Company has purchased a lot and will erect a three-story building for a telephone exchange.

OCALA, FLA.—The Ocala Telephone Company has been organized with a capital stock of $10,000. J. C. Carlisle is president.

ST. JOHNSVILLE, N. Y., is agitating the question of organizing a new telephone company connecting different villages.

BANGOR, ME.—It has been decided to build a telephone line from Gardiner to Camden, thence to Bangor, and from there to Bar Harbor. The line to Camden will be entirely new, and from there to Bangor the old one will be rebuilt.

Electric Light and Power.

HAWKINSVILLE, GA.—Address J. M. Burrows concerning electric light plant to be established.

FRONT ROYAL, VA.—Address the Mayor concerning $6,000 electric light plant to be established.

FRANKLIN, O.—A movement is on foot to organize another electric light company.

JOPLIN, MO.—The Southwestern Electric Light and Power plant of Grand Falls is to be removed to Joplin.

OSAGE, IOWA.—Fire, caused by spontaneous combustion, destroyed the plant of the Osage Electric Light Company. Loss, $50,000, with no insurance.

PENSACOLA, FLA.—The Citizens' Electric Light & Power Company, T. E. Welles, president, is in the market for an entire outfit for an electric light plant.

SUMMIT, N. J.—Summit capitalists are about to form a stock company and erect an electric light plant, which will cost $100,000 and have sufficient capacity to light Short Hills and Milburn.

BROOKLYN, N. Y.—The Aldermanic Committee on Lamps and Gas, Alderman Walkley, chairman, is considering the proposition of the Municipal Electric Light Company to extend its system over the entire city.

CRANFORD, N. J.—Bids will be opened by the Township Committee for lighting the streets of Cranford by either electricity or gas on July 9. The contract will be for two or five years, and R. C. Plume is the town clerk.

GRAND ISLAND, NEB.—After July 10, unless something new turns up in the interval, Grand Island will be without the electric light. The Light & Fuel Co.'s contract expires July 1, and its new bid has been rejected.

LYONS, IA.—The Electric Light Committee was ordered to purchase the following supplies, which they reported as needed: 4,500 feet of line wire, one and a half dozen pulleys, one pair splicing pliers, one pair blocks, 200 wood insulating pins.

ROME, N. Y.—Sealed proposals for lighting the streets with electric light will be received until August 6. Proposals must be for one, three and six years, for 150 arc lights, more or less, of 2,000 candle power each. R. S. Putnam is chamberlain.

WASHINGTON, D. C.—Plans have been prepared by T. F. Schneider, Eighteenth and Q streets, for the erection of a $130,000 fire-proof hotel building for Judge A H. Lowery. An engine and dynamo for lighting will be placed in the building.

HARRISBURG, PA.—The Tremont & Pinegrove Heat & Power Co. has received its charter, and commenced work excavating for the erection of the plant, which will be located between Pinegrove and Tremont and will be run by water power.

NORWOOD, PA.—Proposals for lighting the borough of Norwood with from 50 to 100 lights for two years, from August 1, 1894, will be acted upon by the borough council, July 12, 1894. Address G. C. Skelton, secretary, Box 47, Norwood, Delaware Co., Pa.

CRANFORD, N. J.—R. C. Plume, town clerk, may be addressed in regard to sealed proposals for lighting the streets on a two or five-years' contract, with either electricity or gas. Bids to be opened by the Township Committee at its meeting July 9 at 8 p. m.

PALMYRA, N. Y.—At a meeting of the village Board of Trustees, the parties holding a franchise for erecting a plant in this place were given two weeks in which to decide whether they will erect the plant or not. In the former case work will be commenced at once, and a plant put in operation by September 1.

WASHINGTON, D. C.—Sealed proposals will be received until July 6 for furnishing and delivering at the building for the Library of Congress about 90,000 feet of rubber-coated electric wire. Specifications, general conditions and instructions and blank forms of proposal may be obtained on application to Barnard R. Green, superintendent and engineer.

MAUCH CHUNK, Penn.—The Mauch Chunk Heat, Power & Electric Company has issued bonds for $20,000, and purchased two 23-inch and one 24-inch special McCormick horizontal turbines. It is the intention to add a 1,200-light alternator and a 60 h. p. D. C. generator, which will make the capacity of the plant 3,000 incandescents, 60 arcs and 60 h. p. for power.

The Electric Railway.

JOPLIN, MO.—The Joplin Electric Railway & Motor Company is to extend its lines to Velena.

STEVENS' POINT, WIS.—The Stevens Point Lighting Company is asking for a franchise for a car system.

NEW ORLEANS, LA.—The St. Charles Street Railway Company has applied for a franchise to change its motive power to electricity.

ALVIN, TEX.—The building of an electrical railroad from Alvin to Velasco is proposed. W. A. Rowan, of Alvin, can give information.

CHATTANOOGA, TENN.—The Chattanooga Cotton Oil Company will put in an electric light plant to furnish its own light. Address G. E. Richmond.

NEW CASTLE, DEL.—The New Castle and Wilmington electric railway will not be built under the charter granted at the last session of the Legislature.

FOREST CITY, PA.—Attorney S. P. Weedman and Justice W. J. Maxey are interested in the proposed electric railroad to run from Dundaff to Nicholson.

ST. LOUIS, MO.—The St. Louis & Kirkwood Electric Railway Company has obtained a franchise to build an electric road. Address J. D. Hous for any information.

CLAYTON, MO.—A franchise has been granted to the Clayton & Creve Coeur Electric Railway Company to construct an electric road from Clayton to Creve Coeur Lake. Philip Deuser is interested.

KINGSTON, N. Y.—Reed & McKibben, the contractors who are building the Colonial Electric Railroad, to-day filed a $10,000 lien on the finished property of the company.

JACKSON, TENN.—It is contemplated to reorganize the Jackson & Suburban

Street Railroad Company, and change its road to electric power. P. J. Murray can be addressed.

POWHATTAN, MO.—The Walbrook, Gwynn Oak & Powhattan Railway has executed a mortgage for $100,000 to obtain funds to build and equip a single track electric railway.

TROY, N. Y.—$15,000 has been subscribed to the stock of the proposed electric railroad from Troy to Sandlake. As soon as $25,000 shall have been subscribed other capitalists will furnish an equal sum.

CLAYTON, MO.—The Clayton & Creve Cœur Electric Railway Company has obtained a franchise to construct an electric road. The president of the company is Philip Dueser, who will give information regarding same.

WASHINGTON, D. C.—A project for an electric railroad between Washington and New York city has been brought before Congress in a bill for the incorporation of the National Rapid Transit Railway. Ex-Representative Hemphill, of South Carolina, is interested.

BROOKYLN, N. Y.—An application has been made to the State Railroad Commissioners by the Coney Island & Brooklyn Railroad Company, to substitute the trolley as a means of motive power on the line from Flatbush and Ocean avenues to Greenwood Cemetery.

SPRINGFIELD, O.—General Manager S. L. Nelson, of the Springfield Street Railway Company, is securing estimates for improving the line. The proposed improvements are $40,000 for retracking, $15,000 for new machinery in the power house, $15,000 for new cars, and $5,000 for other expenses.

PITTSFIELD, ME.—It is probable that the proposed electric railroad from Showhegan to Norridgewock will be built. The Worcester Construction Company offer to build and equip the road all in first-class shape for $45,000. If the town will take $10,000 of the stock Mr. Gerald guarantees the building of the road.

WATERTOWN, N. Y.—A certificate of consolidation of the Watertown Street Railway and the Watertown & Brownville Street Railway Company, forming the Watertown & Brownville Street Railway Co., capital $100,000, was filed with the Secretary of State in Albany, June 25. The directors are Byron B. Taggart, Senator Joseph Mullin and others.

SYRACUSE, N. Y.—The Syracuse Street Railway Company has decided to extend its line to Solvay, and a contract has been signed. It was also decided that the company purchase 35 new electric cars and a contract will be made as soon as possible. Specifications and plans for a power house 100 by 150 feet, with a capacity at the start of 1,500 horse power, have been made. The ultimate of the plant will be 3,000 horse power.

MISCELLANEOUS NOTES.

LOCOMOTIVE TESTING AT PURDUE UNIVERSITY is the subject of a pamphlet recently issued by that institution, briefly describing the facilities for that class of work which the university is now prepared to offer students. The pamphlet contains a number of views of the laboratories and locomotives, and it is evident that admirable facilities for locomotive testing are now offered by the engineering course. The engineering laboratory is in charge of Prof. Wm. F. M. Goss.

THE NORTHWESTERN ELECTRICAL ASSOCIATION will hold its Summer meeting in St. Paul July 18, 19 and 20. At the last meeting, held in Milwaukee, 150 were present, and a larger number is expected at this meeting. Representatives from Illinois, Iowa, Michigan, Wisconsin and North and South Dakota have written they they will be present. An excellent programme has been prepared. Current will be furnished to illustrate lectures as well as to accommodate exhibitors. Manufacturers and supply houses will be accorded every courtesy by the association.

TRADE AND INDUSTRIAL NOTES.

S. MORGAN SMITH, York, Pa., has sold to the Mauch Chunk (Pa.) Heat, Light & Power Co. two 23-inch and one 24-inch McCormick special horizontal turbines.

THE CHERRY CHEMICAL COMPANY, manufacturers of the red seal boiler compound, has removed its main office to the Heed Building, 1215 Filbert street, Philadelphia. In our last issue it was incorrectly stated that the removal was to, instead of from, the Betz Building.

J. E. M'GILLIVRAY, 209 Sabine street, Austin, Tex., will shortly be in the market for a stock of electrical goods. Mr. M'Gillivray proposes to handle everything electrical, but most of his work will be in wiring and repairing for lights, bells and annunciators, and installing and repairing motors and fans.

THE OHIO BRASS COMPANY, of Mansfield, O., has issued a neat price list of railway motor bearings. It includes all the different styles of bearings for the various types of railway motors, and makes a very attractive circular. This company is pushing this line of material actively, and is meeting with excellent success.

THE NATIONAL LEAD COMPANY, No. 1 Broadway, New York, has issued a little pamphlet on anti-friction or babbitt metals, containing technical as well as trade information on the subject. The babbitt metal of this company is made according to a standard formula, which it is guaranteed does not change to suit a price.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has issued a large 60-page catalogue, devoted to the description of apparatus and system for the transmission of light and power by two-plant alternating currents. The explanatory portions have considerable technical value, and will be of assistance to those desiring to investigate this newer branch of electrical application. Every part of the system is well illustrated by excellent cuts, made by Bartlett & Co., and the paper, press-work and binding are in keeping with these, and the importance of the text.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, Newark, N. J., has issued a fourth edition of its catalogue of the Weston standard portable, direct-reading voltmeters and ammeters, containing illustrations, price list, etc. Commendable features of the catalogue are the concise manner, devoid of the usual bombast of commercial publications, in which the merits of the instruments are presented, and the brief notes to assist in selecting instruments for desired uses. The testimonials in the final pages are such as but few manufacturers in any branch of industry can boast of having received, whether the standing of the writers or their flattering comments are considered.

THE BALL & WOOD CO. has again been successful in securing, through its secretary and treasurer, Mr. Vincent, one of the largest power contracts which has recently been placed. The order comprises six Ball & Wood improved cross compound condensing engines of 300 h. p. each, for the Hartford Street Railway Company, of Hartford, Conn. It is this type and make of engine which has proved efficient at the Grand Street station of the Consolidated Traction Company in Jersey City, where the duty has been most severe and the engines subjected to almost constant overloads of from 20 to 50 per cent., pending the increase of the power plant. The factory of The Ball & Wood Co. has been running twenty-four hours per day since about June 1, and this Hartford contract will permit no diminution of its force for some weeks.

THE PETTINGELL ANDREWS COMPANY, 72 Federal street, Boston, has issued a 52-page pamphlet, which will be found useful as a technical hand-book by street railway men. About half of the pages are devoted to tables of useful information for the construction of electric railways. The first part contains tables relating to track construction, giving weights and other data relating to rails, rail fastenings, ties, etc. The second part takes up the electrical side and gives much detailed information on line construction and tables for the calculation of line conductors, etc. The remainder of the pages contain illustrations and matter relating to the complete line of electric railway material, manufactured and sold by this enterprising firm.

BUSINESS NOTICES.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED JUNE 26, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

11,423 (REISSUE). ELECTRIC BURGLAR ALARM; A. Stromberg, Chicago, Ill. Application for reissue May 31, 1894. In an electric burglar alarm circuit, the combination with a flexible surface, of a series of pliable conducting strips, the strips being folded longitudinally and attached by one of the free ends thereof to the flexible surface, and electrical connections between the strips.

521,798. ELECTRIC ARC LAMP; S. P. Johnson, Schenectady, N. Y. Application filed December 20, 1892. This comprises an arm actuated by shunt spools, a lever linked to the arm at one end and the other end actuated by a series spool, in combination with a clutch linked to the lever near its centre as described.

521,799. ELECTRIC MOTOR; J. Lee, Brooklyn, N. Y. Application filed August 2, 1893. This comprises elongated electro-magnets having cores and curved facing flanges, combined with a hollow speed regulator in the magnetic field, a revoluble armature within the regulator, commutator and commutator brushes, the conductor being wound around from the obverse to the reverse face of one of the cores and from the reverse to the obverse of the other of the cores.

521,800. SOUND CONDUCTING APPARATUS; G. A. Leech, New York, N. Y. Application filed August 19, 1893. This comprises a resonator having curves complementary to those of the ear, and adapted to be secured thereto, and an electrode attached thereto.

521,808. PUSH BUTTON; J. P. McLaughlin, Philadelphia, Pa. Application filed March 22, 1893. This comprises a switch and spring tending to open the same, in combination with a push piece and intermediate mechanism for closing the switch, and a trip timed with reference to the intermediate mechanism to uncouple the switch from the latter when it arrives in the closed position, whereby the switch is automatically open after having been momentarily closed.

521,809. ELECTRIC LAMP LIGHTER; J. P. McLaughlin, Philadelphia, Pa. Application filed March 22, 1893. A lamp lighter composed of two electro-magnets, connected in series in a shunt around the lamp terminals, one fixed and the other constituting an armature for the first; a circuit breaking and making wheel in the lamp circuit actuated by the armature, and a push button or key in the shunt, at a distance from the lamp, for closing and opening the shunt.

521,843. RHEOSTAT; B. E. Baker, Bridgeport, Conn. Application filed November 27, 1893. This comprises cores having screws extending from their ends and resistance wires wound around them and connected to the screws.

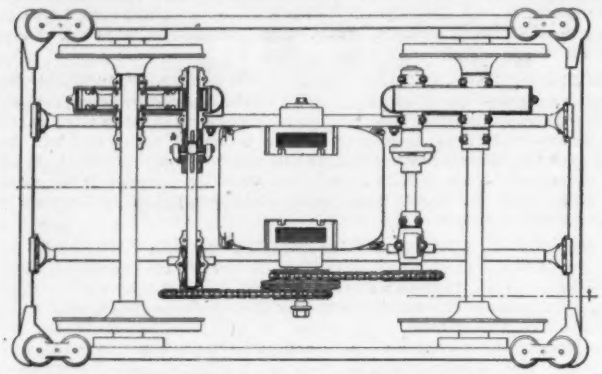
521,867. CONTROLLER FOR ALTERNATING CURRENT MACHINES; E. B. V. Seaverns, Brookline, Mass. Application filed March 29, 1893. The combination with an alternating current machine having a composite field, one winding of which is traversed by a continuous current and is in series circuit with the main line traversed by the alternating current of a switch or circuit controller located in the field winding traversed by the continuous current.

521,877. ELECTRIC ARC LAMP; W. J. Davy, London, England. Application filed April 14, 1894. A gravity friction device, consisting of a system of link,

pivoted together to form a closed frame, grip jaws tending to grip the feeding cord of the lamp, the jaws being attached to a jointed frame in such a position that they approach one another as the frame elongates in a vertical direction, a stop on which the lower end of the link frame rests, and means for determining the position of the upper end of the frame relatively to the stop, according to the resistance of the lamp.

521,891. CONDUIT ELECTRIC RAILWAY; C. J. Reed, Orange, N. J. Application filed April 14, 1892. A pair of positive and negative trolley wires located in a slitted conduit and crossing each other at intervals so as to form succeeding sections in alignment, and beneath the slit of the conduit.

521,892. CONDUIT ELECTRIC RAILWAY; C. J. Reed, Orange, N. J. Application filed February 13, 1893. A trolley consisting of a two-part trolley wheel, one of which parts is provided with an inwardly extending boss or



No. 522,067.—Motor Suspension.

projection, which constitutes the axle of the trolley, in combination with a trolley arm journaled upon the axle, and held between the two parts.

521,906. MAGNETIC SEPARATOR; H. Carmichael, Malden, Mass. Application filed November 29, 1893. The combination of a movable carrier or support and a magnet pivotally attached thereto, and a receptacle through which the magnet is passed.

521,908. AUTOMATIC SAFETY JOINT FOR ELECTRIC WIRES; J. H. Curry, Wilkinsburg, Pa. Application filed November 22, 1893. This consists of a box or support having two insulated anchorage pins, and two arms connected with the pins by a loose-slotted connection with supporting seats for sustaining the arms when under tension, and a bridge connection for the two arms for electrically connecting them when supported by tension in these seats.

521,914. ELECTRIC SOLDERING TOOL; J. F. McLaughlin, Philadelphia, Pa. Application filed May 19, 1893. The combination of a heating coil and a perforated inclosing mantle for the same, with means for controlling the radiation of heat through the perforations.

521,924. TRANSFORMER ELECTRIC-LIGHTING SYSTEM; Peter Wright, Philadelphia, Pa. Application filed December 9, 1893. In a transformer system of electrical distribution, mechanical and electrical devices for breaking and making the primary circuit, and a manual switch and connections for cutting out, and in the secondary circuit, and for controlling the mechanical and electrical devices.

521,925. TRANSFORMER SYSTEM OF ELECTRICAL DISTRIBUTION; Peter Wright, Philadelphia, Pa. Application filed January 3, 1894. In a transformer system of electrical distribution, a switch tending to make and break the primary and secondary circuits of a transformer and a thermostatic device responding to changes in current and adapted to release the switch.

521,936. ELECTRIC ARC LAMP; L. B. Marks, New York. Application filed March 30, 1894. An arc lamp having the arc surrounded by a transparent or translucent inclosure, and a plug in the inclosure provided with a closely fitting opening for transit of the moving electrode, the opening being enlarged at an intermediate point for the purpose.

521,952. ADJUSTABLE CARRIER FOR ELECTRIC LAMPS; R. Faries, Decatur, Ill. Application filed February 23, 1894. An arm for electric lamps, comprising a bracket or support, having an aperture, a rod, one end of which is curved and adapted to the aperture of the support, a lamp socket on the swinging end of the rod and a lamp cord or circuit wire connecting with the lamp socket through a longitudinal aperture in the rod.

521,970. ACCUMULATOR PLATE; C. J. Barbier, Lyons, France. Application filed January 12, 1894. An improved accumulator plate, comprising a flat lead box for containing the active matter, the box having its opposite sides provided with alternately arranged pins overlapping or projecting past each other, the walls of the box having perforations opposite the points of the pins.

521,976. THICKNESS GAGE FOR PAPER-MAKING MACHINES; O. W. Theodor Am Ende, Bad Harzburg, Germany. Application filed November 10, 1893. This comprises an adjustable graduated slide, carrying a contact point, the means for adjusting the slide, the frame in which the slide is movable, the arms pivoted in the frame and depending from their pivotal points, the cross bar at the lower ends of the arms opposite the end of the graduated slide and the contact carried thereby, and the roller carried by the depending arm to bear on the pulp cylinder to move the pivoted depending arms toward the graduated slide.

522,022. THERMAL ALARM; H. F. Maxim, Norfolk, Va. Application filed August 31, 1893. The combination of the index, pivoted pointer, having a slotted heel, a thermostat bar actuating the pointer, and a bar adjustable on the thermostat bar, and having a projection lying in the slot.

522,051. BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES; R. Fuller, Detroit, Mich. Application filed March 19, 1894. In a brush holder, the combination of a brush-holding socket, having the central transverse guide bearing thereon, a lateral arm extending from the socket, and adjustable standard in the end of the arm, and a spring secured in the standard, and adapted to engage in the guide bearing of the socket upon the brush.

522,052. COMMUTATOR; J. D. Fyfe, Chicago, Ill. Application filed April 14, 1894. A commutator composed of segments insulated from each other and arranged in the form of a cylinder, and provided with an annular groove in the face or end thereof, a metallic assembling ring adapted to fit into the groove and insulated from the segment, caps located on opposite sides of the segments and insulated from them and the ring, the caps adapted to secure the assembling ring in the grooves of the segments.

522,055. CIRCUIT-MAKER; D. F. Hall, Schenectady, N. Y. Application filed October 16, 1893. A circuit-maker, comprising a bracket, a support in arm pivoted thereto, a battery receptacle having circuit-wires secured thereto, and in which receptacle the elements forming the battery are held normally apart, and adapted to coalesce when the receptacle is inverted.

522,057. TROLLEY STAND; E. F. A. Heastings, Avalon, Pa. Application filed April 12, 1894. A trolley stand, comprising a base, adapted to be secured to a car, a pivot post mounted in the base, a bracket journaled on the pivot post and provided with upwardly extending arms, a second bracket held in the arms of the first one and adapted to carry a pole, and bow springs connecting the two brackets.

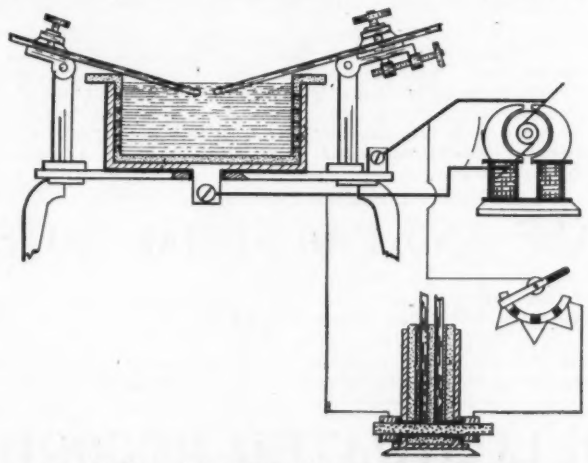
522,067. MEANS FOR SUSPENDING ELECTRIC MOTORS FROM CARS; R. Lundell, Brooklyn, N. Y. Application filed September 4, 1893. A motor, sustained beneath the body or frame of a car upon yielding supports, with its armature shaft located in the direction of the length of the car and sprocket-chain gearing connecting the armature shaft with an additional rotary shaft, which in turn is geared through speed-reducing gearing to two independent car axles. (See illustration.)

522,083. DYNAMO OR MAGNETO ELECTRIC MACHINE; L. Paget, New York. Application filed June 20, 1889. This machine has a rotary part with projecting pole pieces in combination with a fixed or stationary part, having corresponding projecting pole pieces and a single coil wound about the fixed or stationary part.

522,097. ELECTRICALLY OPERATED ADDING MACHINE; R. Baumann, St. Louis, Mo. Application filed September 4, 1893. This machine has grouped within its casing in a horizontal line a series of electro magnets, each elongated in cross sections, and constructed with flat opposite sides closely adjacent, a series of adding disc spindles with ends adjacent the magnets, and in the same plane with them, mechanical connections for rotating the spindles when the magnets are energized, the last mentioned connections being also in the same horizontal plane as the magnets.

522,113. ELECTRICALLY OPERATED REGISTER; S. J. Glass, Milwaukee Wis. Application filed October 23, 1891. A register of that class employed for counting the movement of a reciprocating, oscillating or rotary device or the successive production of various articles, the same comprising a series of counters geared in train to indicate arithmetical progression in the order of units, tens, and multiples of ten, a ratchet connected to the units counter, an actuating lever for the ratchet, another lever linked to the first mentioned, an armature carried by the second lever, an electro magnet for the attraction of the armature, and a supplemental electro magnet for the retraction of the armature, each of these electro magnets being in independent circuit and automatically cut out prior to the energization of the other.

522,127. VOLTAIC BATTERY; H. Timm, New York. Application filed April 19, 1894. This is composed of two absorbent layers, enclosing a dry layer of a soluble electrolyte, a series of metallic plates of different polarity in close



No. 522,151.—Heating Metals Electrically.

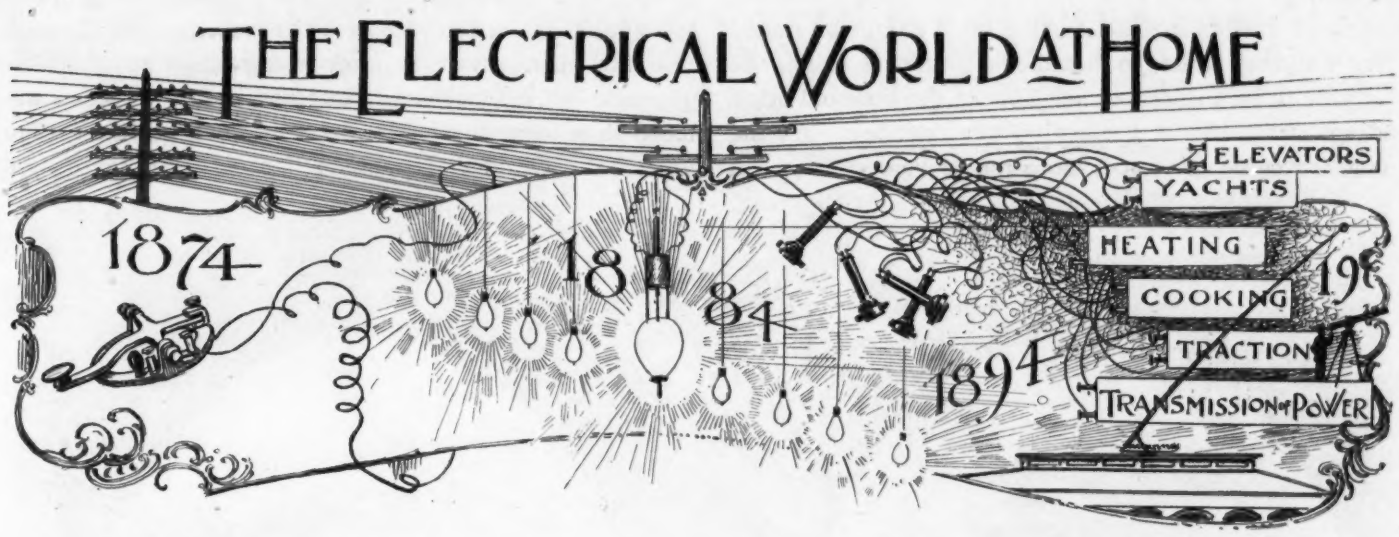
contact with the absorbent layers; two other absorbent layers are placed on the outside of faces of the metallic plates; a second series of metallic plates of different polarity in close contact with the last-mentioned absorbent layers, metallic connections between the outside metallic plates, and metallic connections between the inside metallic plates.

522,151. METHOD OF HEATING METALS ELECTRICALLY; C. L. Coffin, Detroit, Mich. Application filed November 16, 1893. This consists in dipping a heated piece of metal into a liquid, passing an electric current through it and the liquid, and establishing a voltaic arc between the electrodes. (See illustration.)

522,175. INSULATOR; J. M. Anderson, Boston, Mass. Application filed March 22, 1894. This is composed of a body portion of insulating metal, a metal crown having upright arms or ears, forming a slot or channel for the reception of the conductor to be supported, and a cap or cover detachably secured to the arms to close the slot or channel at its top or upper portion.

522,180. TROLLEY WIRE HANGER; T. J. McTighe, New York. Application filed January 23, 1893. A trolley wire attachment, consisting of an ear or casting of suitable shape, having a slotted screw threaded stud, adapted to receive the trolley wire, a flat plug substantially filling the slot, and a screw cap adapted to fit the stud, and press the plug against the trolley wire.

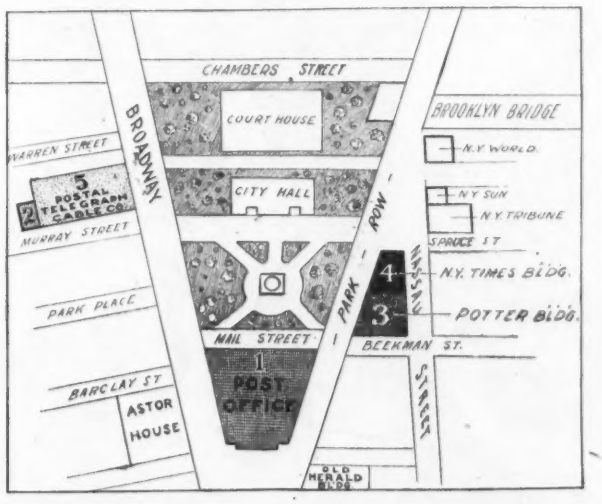
622,029. ELECTRIC TIME SIGNALLING SYSTEM AND APPARATUS; W. A. Purcell, Newark, N. J. Application filed November 16, 1892. The combination with a circuit wheel or drum, provided with a series of contact ribs of definite width, of another rib or ribs of greater width, and a circuit breaker wired to the last mentioned rib or ribs.



Look on this beautiful world, and read the truth
In her fair page; see, every season brings
New change to her, of everlasting youth.

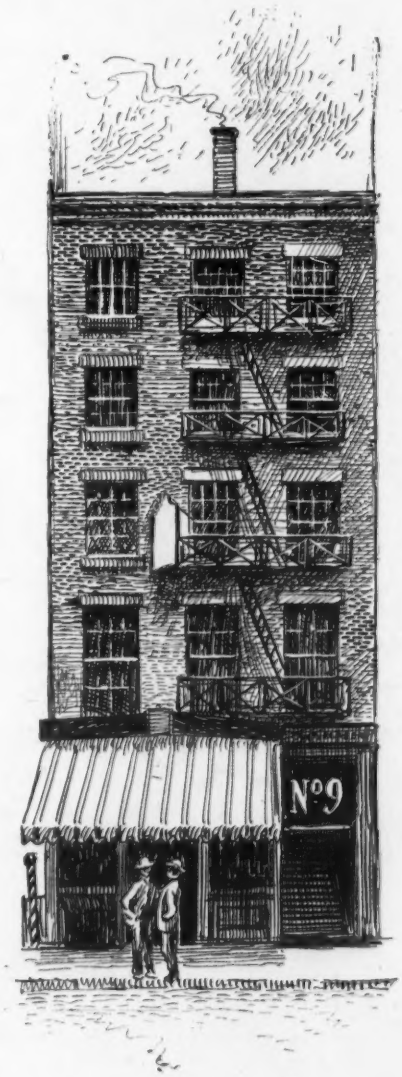
WILLIAM CULLEN BRYANT.

WITH its first issue dated March 3d 1894, The Electrical World celebrated the beginning of its third decade, and the number for May 5, 1894, was published from its new offices in the Postal Telegraph Building, 253 Broadway, on the corner of Murray street. Prior to its latest removal the paper had changed its quarters but twice since it occupied its first office at No. 9 Murray street. It is, perhaps, worthy of mention in passing that in its several changes of residence it has never wandered far from its original location, the different buildings in which it has made its home being all within sight and gun shot of each other.



THE DIFFERENT HOMES OF THE ELECTRICAL WORLD.

THE EVOLUTION. Being now comfortably established in its new quarters, The Electrical World takes pleasure in publishing herewith views of its different departments, illustrating the latest stage of an evolution from a most humble beginning, in 1874, when a post-office box and the use of a desk at the printer's served the purposes of business office and editorial sanctum. What, however, was then lacking in one respect was compensated for in others. Dreams of the future made up for the deficiencies of the present, triumphs were magnified by the surroundings, and difficulties in that youthful period were almost welcomed for the pleasure found in subduing them.



This fond attachment to the well-known place
Whence first we started into life's long race
Maintains its hold with such unfailing sway
We feel it e'en in age and at our latest day.

COWPER.

With the modest requirements of those days the facilities mentioned sufficed, while pride was so entirely engrossed in the pages of the new journal as to have no care for material

surroundings. After awhile, however, increasing business necessitated greater facilities, and a small room was rented at No. 9 Murray street, so that the last removal brings the paper back to be a next door neighbor of the little old brick building in which its prosperity was founded. As the demand for space increased, more rooms were added, until finally the great growth of the paper and an appreciation of the desirability of quarters of a more modern character, led to the rental of a large space in one of the first of the great office caravansaries, the Potter Building. The press for still more room, however, was soon felt again, and in 1889 a second removal was made to the new Times Building, where the offices remained until May of the present year. In each case the change was to more commodious and desirable quarters, but the increase in expense in this direction was more than compensated for by additional business. The Electrical World's reputation for modesty is so well established that it may venture to add that it has the satisfaction of occupying the most commodious suite of offices of any purely technical journal in the world.

Glimpses of Printing House Square Through The Electrical World's Spectacles.

THE BUILDING.

As will be seen from the illustration, The Postal Telegraph Building is an impos-

ing pile. Though it towers fourteen stories above the ground, the architects have been unusually successful, not only in avoiding an appearance of unnatural height, but in handsome cornice. The building has an admirable situation, being directly opposite the City Hall, and diagonally across City Hall Park from the great daily newspaper buildings,

The Postal Telegraph Building from the Times Building.

happily blending grace of design with a sense of solidity. Artistic effects have not been neglected, as is shcwn in the decorations about the great portal, and in the details of the the Potter Building and the Post-Office, all of which are visible from the new offices. A more desirable location it would be difficult to find.

ELECTRICAL FEATURES. The part which electricity plays in a modern office building is becoming greater every day, and in the Postal Building has reached a high-water mark. The extent of the power used may be judged from the fact that the dynamo capacity for the electric elevators, for lighting and for telegraphic purposes, though the latter is but a small fraction of the whole, aggregates no less than 625 horse-power, or sufficient to run an express train continuously at a high rate of speed. As an instance of a comparatively recent advance in electricity here exemplified, it may be remarked that the motor-dynamos supplying all the Postal Telegraph lines with current could be placed in the space occupied by a few hundred gravity cells, and yet they furnish, at an insignificant expense, and with only one attendant, the current that otherwise would require thousands of cells occupying an immense space, with corresponding cost for labor and chemical materials. The electrical plant is in the sub-basement, and marks a great advance in its details over the rather crude apparatus installed in office buildings only a few years ago.

THE OFFICES. The space occupied by The Electrical World comprises the entire Broadway front of the third floor, extending back forty feet along Murray street. The paper has no fewer than twelve different windows for its signs—three on Murray street and nine on Broadway—and as the offices are but the second floor above the street, it would be difficult for anyone to walk up or down lower Broadway without being aware of the location of The Electrical World offices. The third is the only floor on which there are oval windows and all three of these are in its space. These oval windows are so unique and handsome that we give an illustration of one of them in detail. Whether the visitor on entering the building walks up the two easy flights or ascends by one of the electric elevators, on reaching the third floor and turning to his left, he will find the offices of The Electrical World directly in front of him.

THE ELECTRICAL WORLD
THE ELECTRICAL WORLD
THE ELECTRICAL WORLD
THE W. J. JOHNSTON CO. LT'D ELECTRICAL BOOKS
JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY
50

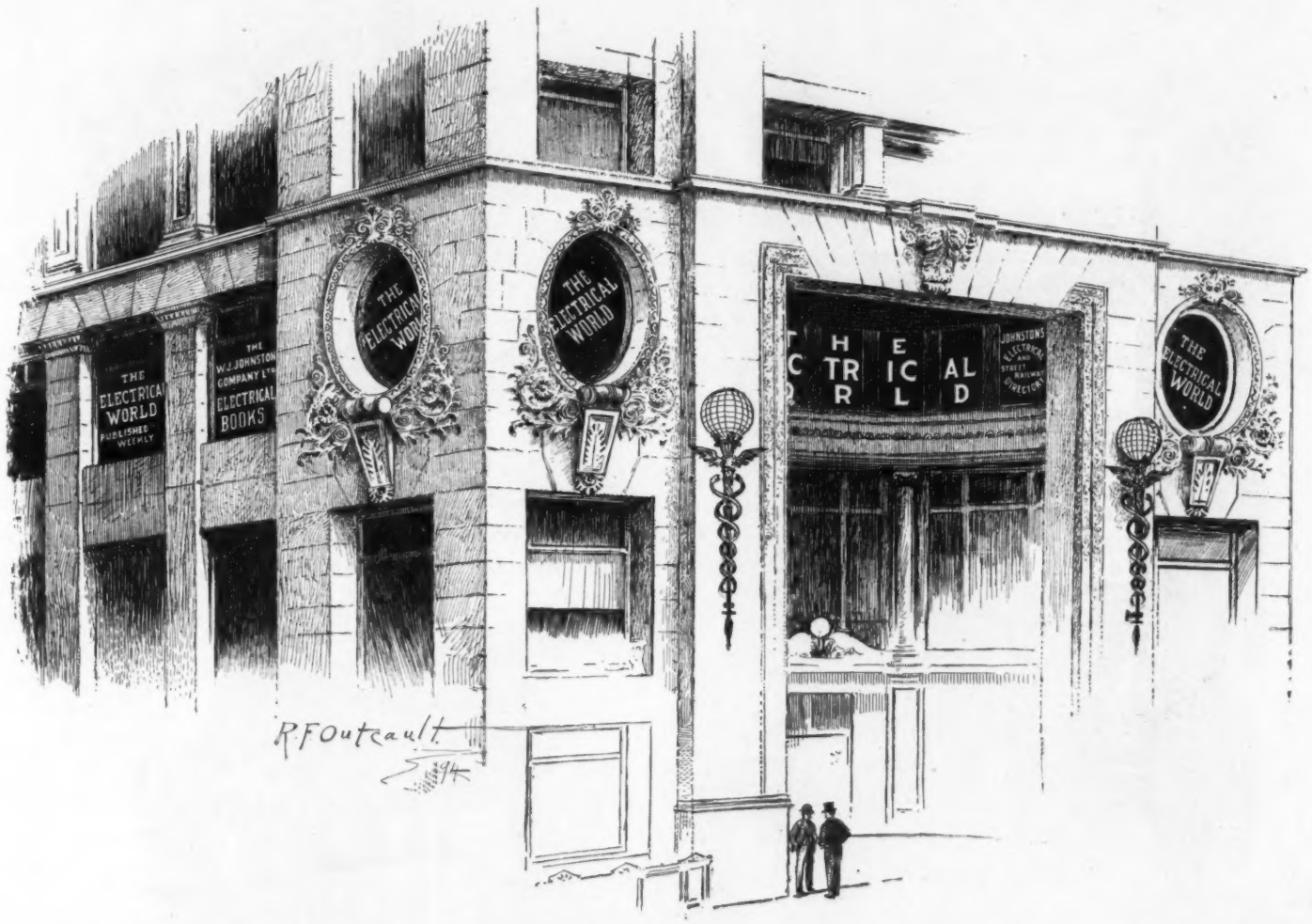
Front View of the Building.

RECEPTION ROOM. From the hall one enters the reception room, where everything will be found arranged for the convenience of the visitor. An attendant

will take his card, or announce his name, if he desires to see any one connected with the business or the editorial department, or place at his disposal files of the various electrical papers, or permit him, at his leisure, to examine the books in a case containing a copy of every electrical book on the market, whether American or English. This latter is a privilege highly appreciated by the book purchaser, for here he may come with an assurance that he can obtain just the book he needs, if published, or by a personal search be enabled to determine which fulfils his requirements in the greatest degree. An expert knowledge, extending over the entire range of electrical literature, is at his service for advice or direct assistance in making a selection, and should the information required not be found in books, a complete set of indexes of The Electrical World at hand will probably bring to light articles on a given subject, and copies of the paper containing them can usually be supplied. Our friends are always welcome here, and information relating to electrical subjects will be most willingly given.

PUBLISHER'S OFFICE. Adjoining the reception room is the private office of the publisher. The Broadway front of this admirably situated room is formed by three of the seven windows in the upper portion of the great hemistyle which furnishes such a noble setting for the main entrance to the building. The view is thus directly down on Broadway, and on the stream of tens of thousands of persons who daily pass by this busy corner, situated as it is in the heart of the business center of the continent.

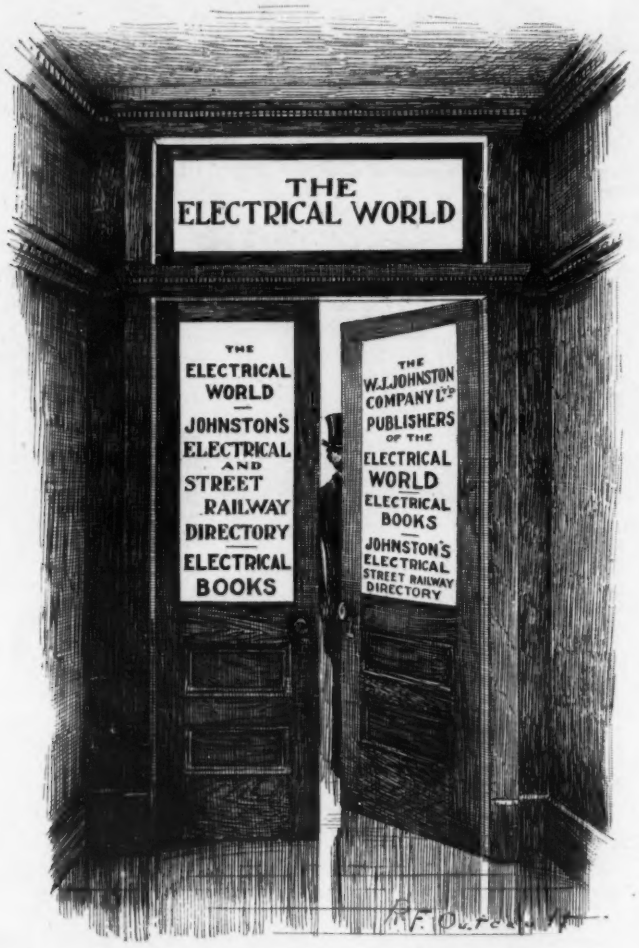
BUSINESS DEPARTMENT. The main business office, on the right of the reception room, is a room 24 by 40 feet, occupied by the force that is found necessary to attend to the vast and growing details of The Electrical World, its publishing and bookselling departments and the compilation of "Johnston's Electrical and Street Railway Directory." Here the business of the several departments is concentrated and systematized, and here the daily reports from the branch offices, from traveling representatives and from correspondents in all parts of the world, keep The Electrical World in most intimate touch with the elcetrical industries of both hemispheres. As shown elsewhere, since the price paid by subscribers scarcely defrays half the mechanical cost alone of the paper, the returns from advertising must supply the deficit as well as make good the other great outlays, besides providing a profit. This branch therefore, assumes a vast business importance and naturally receives correspondingly close attention. The most minute information is here kept, thoroughly revised to date, not only regarding present advertisers but with respect to firms that may possibly advertise in the future. Every move in the business world, every fluctuation in commercial activity, every new development in the electrical and allied industries, is here carefully noted and acted upon. From the intimate insight thus gained the business office may be likened to a



As Broadway Pedestrians See It.

delicate barometer. In fact, so much is this the case that a coming reduction of a given advertisement can almost always be predicted with certainty, and the prospects of an increase is usually known even before the mind of the advertiser has considered the subject. The correspondence necessary to keep up this perfect adjustment, added to that of the Directory, subscription, bookselling, publishing, cashier's and bookkeeping departments, is necessarily vast in its proportions.

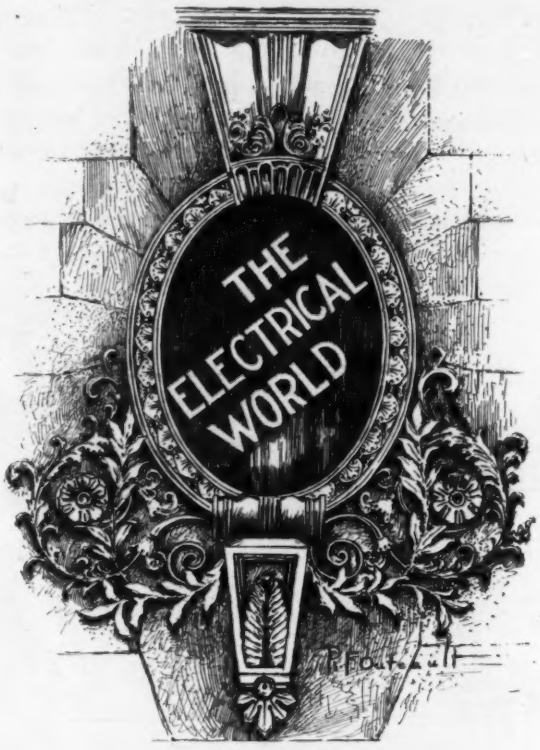
PUSHING CIRCULATION. The circular or circulation department is an important feature, for a fixed policy of The Electrical World is to never cease the effort to increase the number of its readers. Yet each subscription


THE ELECTRICAL WORLD
THE ELECTRICAL WORLD — JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY — ELECTRICAL BOOKS
THE W.J. JOHNSTON COMPANY L'D PUBLISHERS OF THE ELECTRICAL WORLD ELECTRICAL BOOKS — JOHNSTON'S ELECTRICAL STREET RAILWAY DIRECTORY

ENTRANCE TO THE OFFICE.

registered involves a loss at least equal to the amount received for it, and no less a sum than $25,000 a year is spent on subscriptions more than the receipts from that source; but it is recognized that the greater the circulation the wider the influence of the paper and the more valuable it becomes to the advertiser. In addition to the largest circulation of any electrical periodical in the world, The Electrical World has the distinction of possessing the most cosmopolitan circle of readers. It also prints more advertising than any other journal of its class.

JOHNSTON'S DIRECTORY. The thousands of names in the Directory, as well as the items of data in its various departments, are corrected from day to day as changes are received, and then the entire work is revised before the book goes to press. This revision or verification requires the mailing of many thousands of requests for the necessary information. The great labor in this department would be materially lightened if all those interested would fully recognize the value of their aid to the electrical industries at

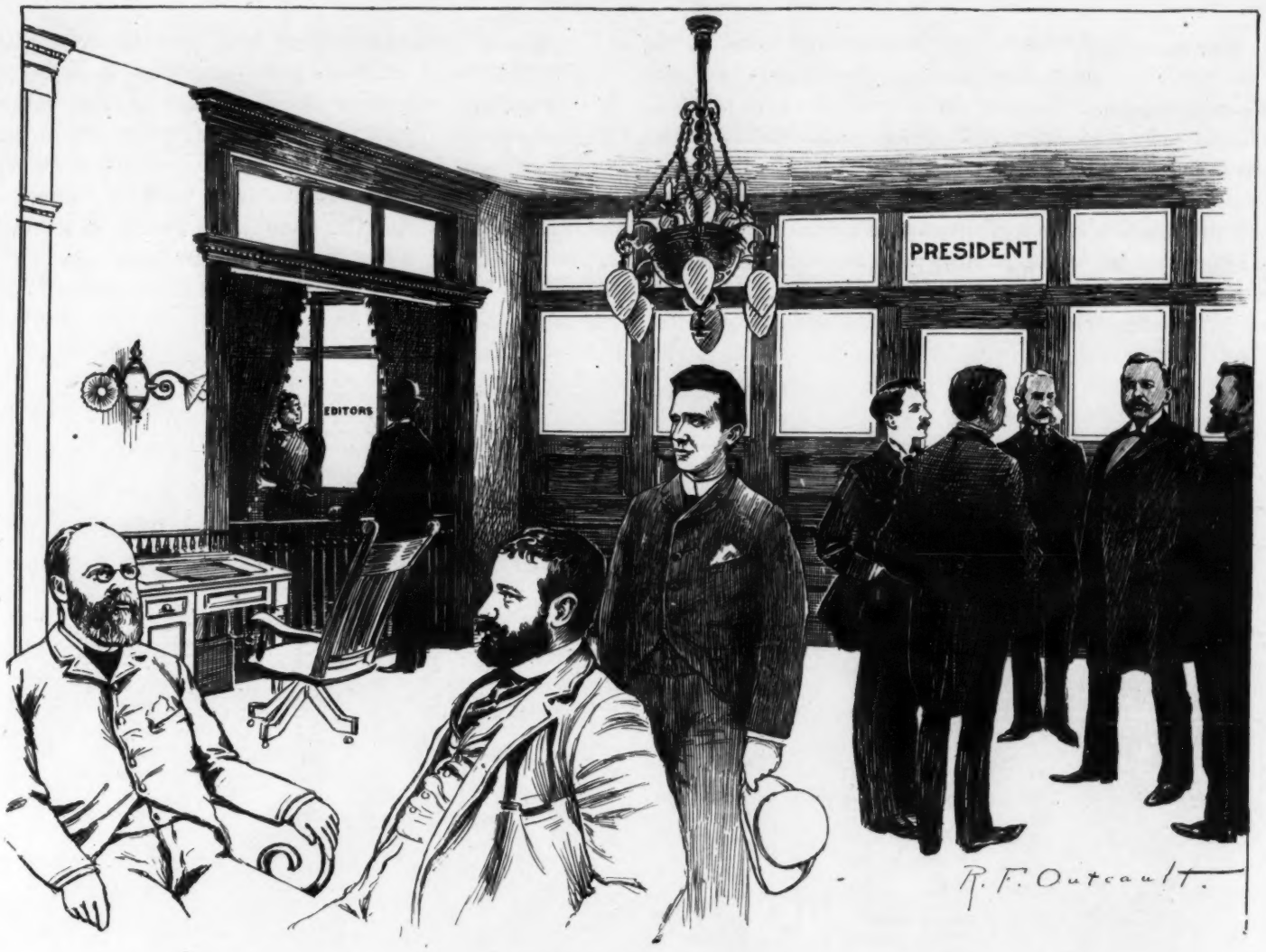


ONE OF THE OVAL WINDOWS.

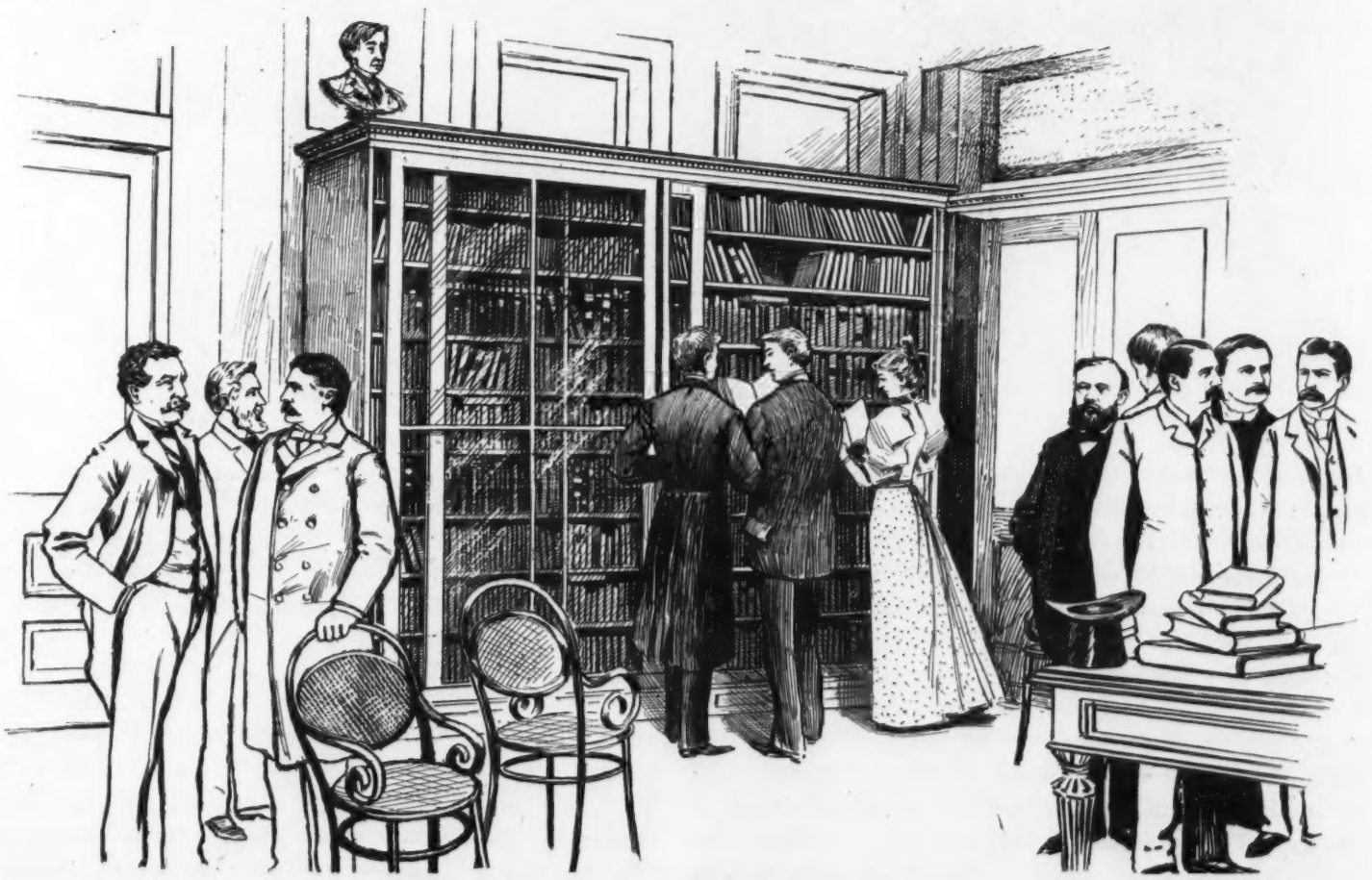
large in freely according the slight attention which the requests addressed to them call for. A Directory to be of value must be accurate and complete, and come to be

PREPARING ILLUSTRATIONS FOR THE ELECTRICAL WORLD

regarded as the standard in its line, and it is the aim to make Johnston's Electrical and Street Railway Directory just this. The intelligent co-operation of all those engaged in every department of the electrical business is asked to this end.



The Reception Room.



Retail Book Department.

OTHER BOOKS. To the left of the reception room are the stock and mailing departments and the editorial offices. In extensive alcoves is kept what is believed to be the largest stock of electrical books in America and perhaps in the world. The publications of the W. J. Johnston Company, Limited, alone now comprise thirty-four titles, which is a larger number of electrical books than is issued by any other publisher in America or England and possibly the world. In addition, the stock contains copies of every electrical book on the market, enabling orders to be filled on the day they are received, an appreciation of which fact doubtless in part accounts for the great proportions which the bookselling department has attained.

SHIPPING DEPARTMENT. In the mailing room are the letter files, in which are kept, so arranged as to be easy of access, the extensive correspondence of the various departments of The Electrical World. Outside of this is a large room for the packing of books, reception of stock, etc. Adjoining are the book alcoves, already referred to, and also alcoves containing thousands of cuts, numbers of The Electrical World for two years back (the older numbers being kept in a stock room in the basement), circulars, stock, etc.

Entrance to the Business Office.

EDITORIAL ROOMS. The editorial department is in a secluded nook, facing on Broadway, and in every way advantageously situated. The large oval window in the main editorial room frames a pleasing view, the City Hall embowered in trees, its beautiful tower and that of the New York World Building beyond making a group which always excites a lively interest in artistic visitors. The editorial equipment comprises among other things a reference library and a current file of every electrical periodical in the world, both of which are at the disposal of those making special researches.

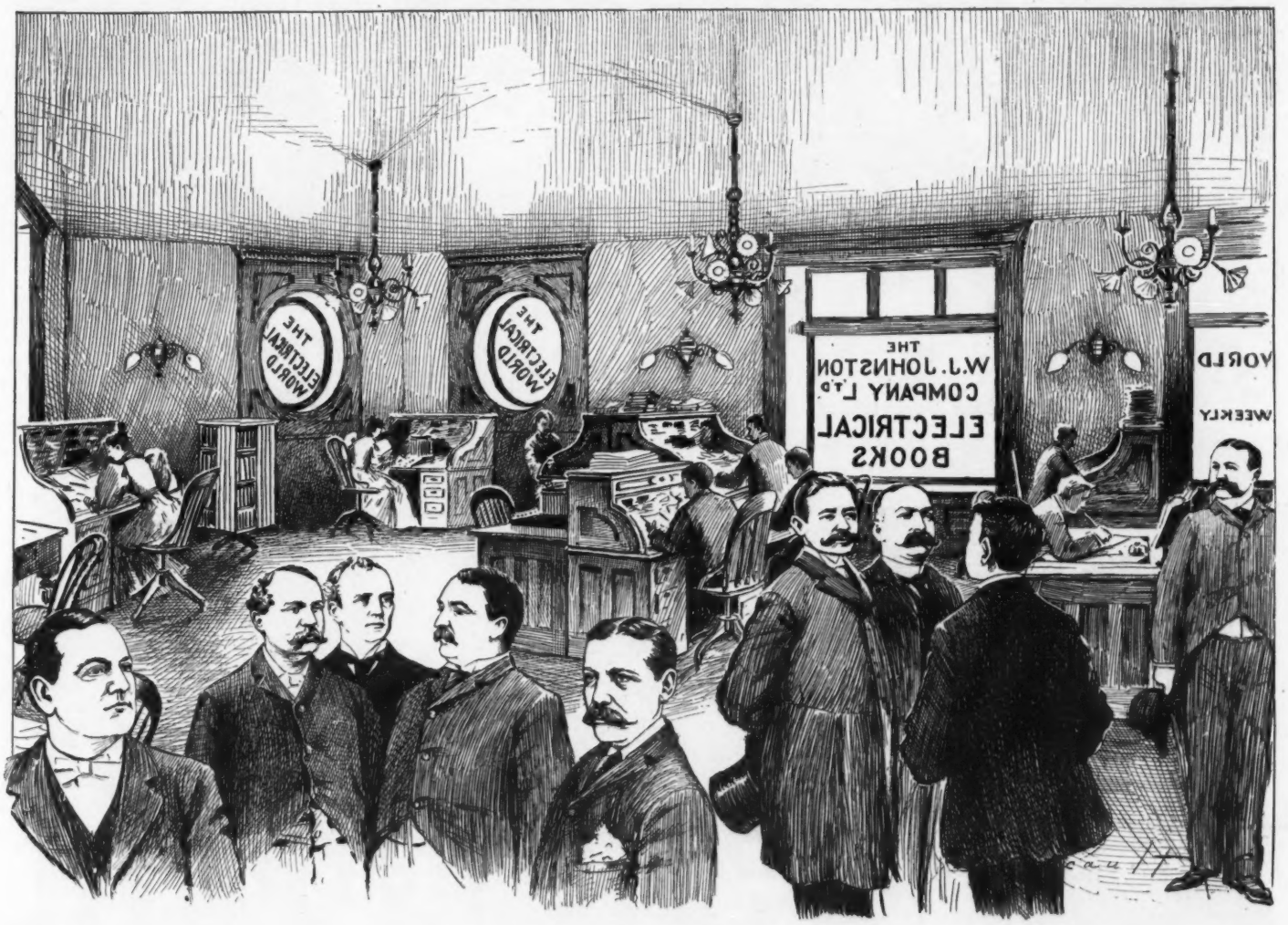
LOOKING BACKWARD. Having now inspected its latest quarters, it may not be uninteresting to take a glance at the history of the journal which requires such an extensive establishment for the transaction of its business. We therefore reprint from a pamphlet issued some years ago the following story of its early days:

THE OPERATOR. "The beginnings of The Electrical World were certainly of the most modest and unpretending character. Under the name of The Operator the paper made its first appearance March 1, 1874, and hence may justly claim a very respectable seniority among the publications of its class. At that time the resources of the small semi-monthly sheet consisted mainly of great expectations. The scope of practical electricity

then was extremely narrow. Telegraphy was the only application employing capital and labor to any large degree, and telegraphy, as personified in the Western Union Company, had its own official organ. But it was thought that the operators would support a paper issued to advocate their interests, and thus the trial was made. The first investment in it of the publisher of The Electrical World was the sum of $50—no small amount to a young telegrapher. Although The Operator was an undoubted journalistic success from the start, it was for a considerable time far from remunerative. In fact it required at times exceedingly close economy on the part of the ambitious proprietors—both working operators and employees of the Western Union Company—to bring their living expenses within the rather slender amount that remained of their salaries after paying the difference between the expenses and the receipts of the paper. Statistics show that scarcely one periodical in ten proves a financial success, and that the greatest mortality among newspapers occurs during the second year. The Summer is always a trying season for a young journal that is not over robust. 1875 was The Operator's second year. That Summer saw it still fighting for a foothold, although perhaps with less enthusiasm than it had manifested earlier in the campaign, for by this time the struggle seemed a rather vain and hopeless one. At last Mr. Johnston, who had contributed an occasional article written during his scant leisure, found himself in a position of responsibility as joint editor and publisher; and before long, in consideration of $250, to be paid off in instalments, his associate, weary of the enterprise, retired, severing all relationship with the paper.

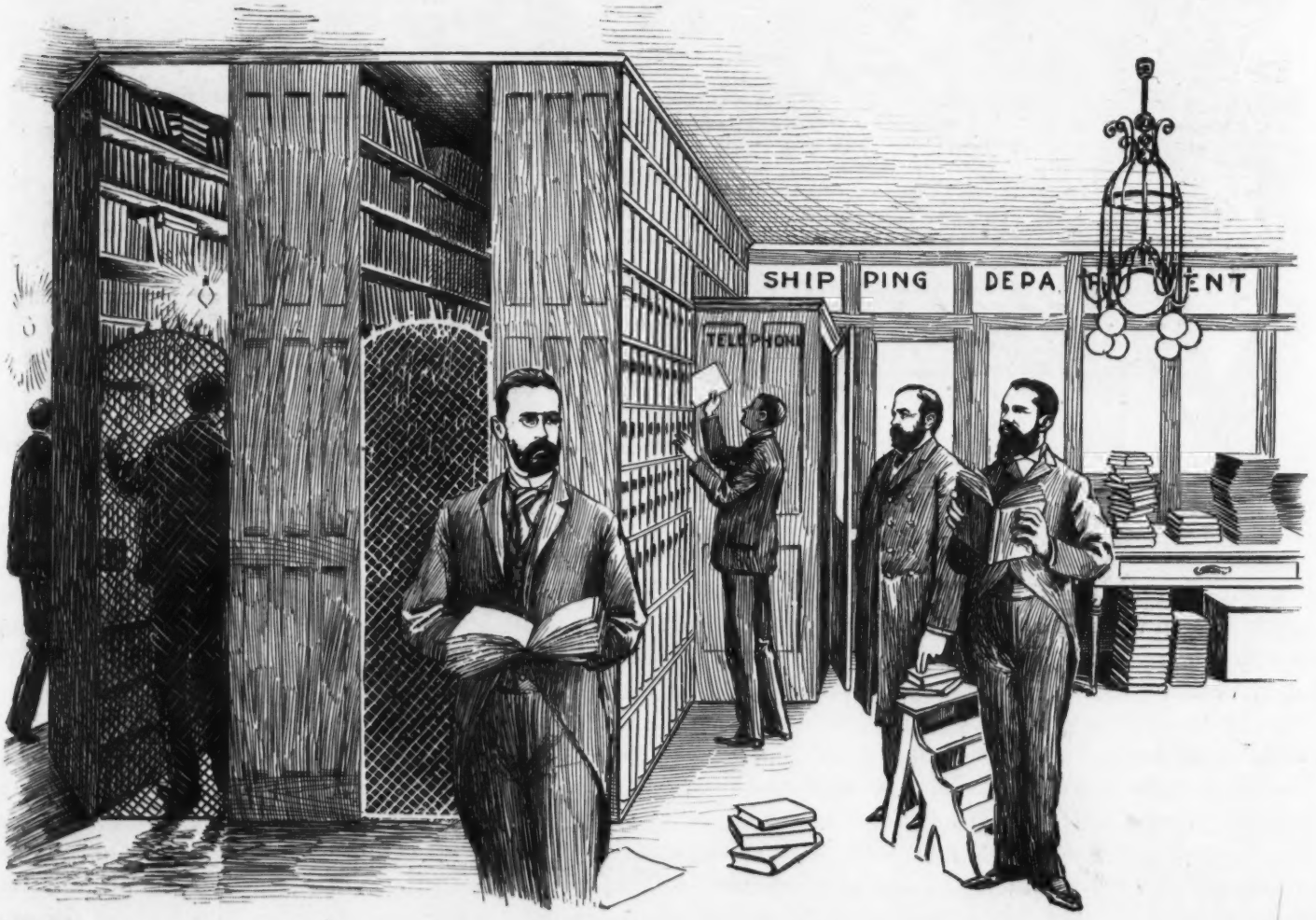
TURNING POINT.

"Those were dark days, but not the darkest. No sooner had the ownership become vested in one person than the Western Union Company thought fit to take action directly and summarily, with a view to suppressing the paper, and Mr. Johnston, then in charge at night of an office on Sixth avenue, in New York, received a letter from the superintendent's office, delivered by special messenger, and calling for an answer. This letter ran partly as follows: 'Your continued employment with us will necessitate your giving up all connection with the paper of which, I understand, you are now proprietor and publisher.' The choice thus forced on one who had just before assumed an indebtedness of $250 for the paper he was now instructed to give up, was desperate, but the answer that went back was this: 'You give me the choice of either giving up all connection with the paper or of leaving the service. I choose the latter and hereby tender my resignation.' Two days later Mr. Johnston was relieved. Although from that time until the present he has seen no



Main Business Office.

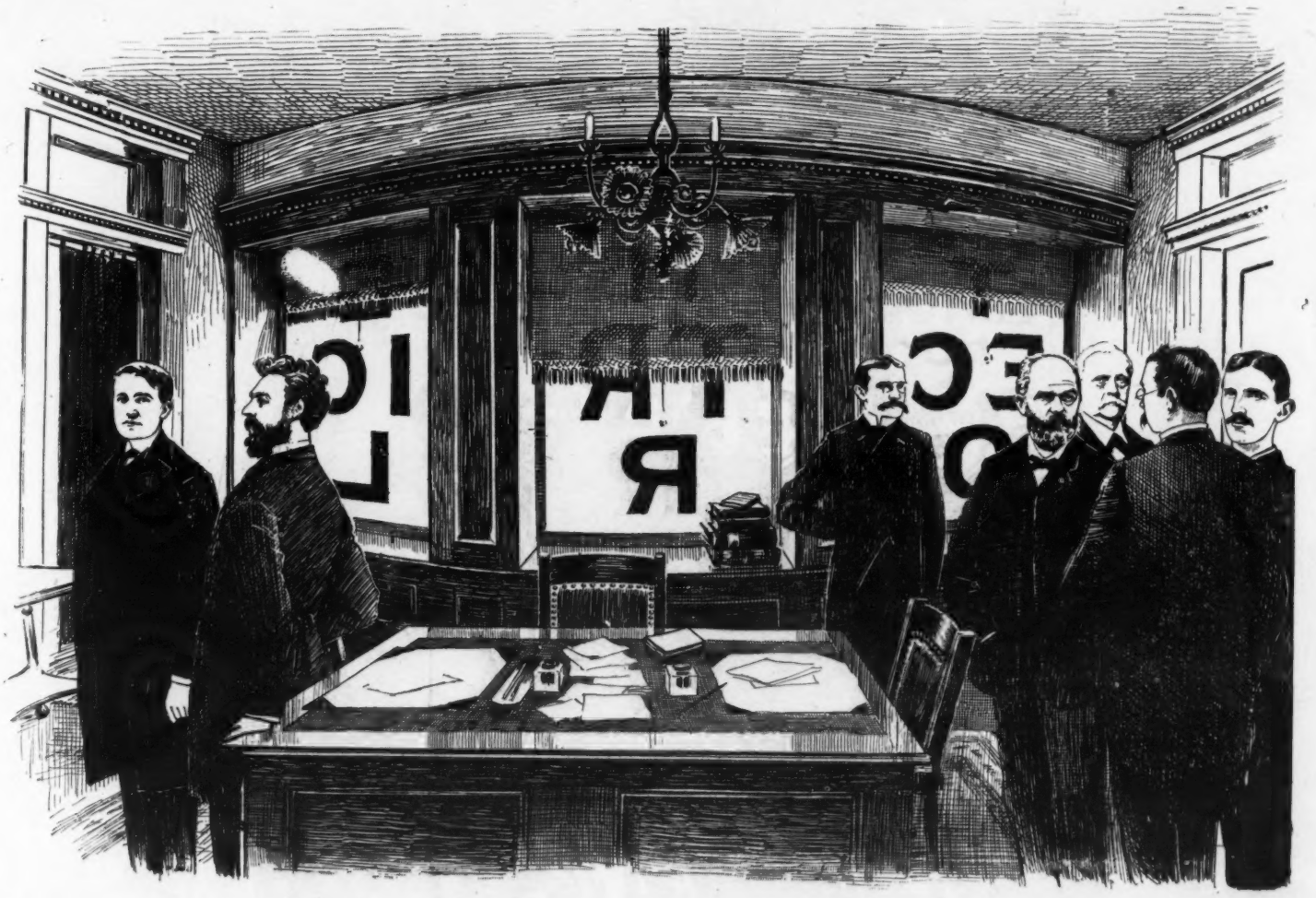
Directory Department, Showing Cashier's and Bookkeepers' Departments.



Book and Shipping Department.

reason to regret the sacrifice of his position, the outlook was exceedingly gloomy at the outset, with debt, a limited subscription list and few advertisers; but the telegraphic fraternity were quick to recognize the significance of the incident, and immediately rallied to the support of The Operator as a representative, independent journal. Even then there were times when indulgence in an extra street-car ride, on business, had to be gravely considered, and when the chance payment of a stray subscription served most opportunely to bridge an awkward gap between one breakfast and the next. But by dint of hard work, and by discharging all the various duties of editor, publisher, reporter, messenger, canvasser, business manager and mailing agency, the items of interest regarding this new and important outgrowth of telegraphy.

ELECTRIC LIGHTING. "In like manner an Electric Light Department was established when an interest began to be felt in electric illumination. Regular articles—in fact, regular series of articles—on both electric lighting and telephony, from the pens of well-known experts, were also published, and many men now prominent in these branches of electrical industry can trace their first practical knowledge of the subject to the columns of The Operator. Thus the paper grew and strengthened with the marvelously rapid progress of electrical science; but it was found that to keep abreast of the numerous and growing applications of



The Publisher's Room.

Mr. Johnston soon turned the corner, and had the gratification of placing The Operator on a solid financial footing, as well as of seeing it strongly intrenched in the esteem of every right thinking telegrapher in America. The practical acquaintance with details that this experience gave him has, moreover, stood Mr. Johnston in excellent stead since, for it enables him to properly appreciate the character of the work that is done in every department of the paper, and even to lend a hand in or take temporary charge of any department whenever the necessity arises.

THE TELEPHONE. "The advent of the telephone was, of course, of very material advantage to The Operator, as it considerably widened the scope of the paper. A Telephone Department was added, in which to chronicle electricity, it would have to be issued oftener, and some radical changes would be required, affecting not only the character of the paper, but even its title.

THE WEEKLY. "Beginning with the first issue of October, 1882, The Operator therefore became a weekly, and on the sixth of January following the size of the page was increased to almost double what it had been, and the name changed to The Operator and Electrical World which finally, with the issue of April 28 following, was shortened to The Electrical World."

THE ELECTRICAL WORLD. The subsequent career of The Electrical World is that of an uninterrupted series of successes—a record of progress in keeping with the marvelous advances made during the same period in electrical

science and its industrial applications. As a consequence the reading columns of the paper are a complete exhibit of the various technical and scientific stages of this development, while the advertising pages in no less a measure show the rate and extent of the industrial expansion.

REGARDING ADVERTISING. Referring first to the advertising pages as admitting more readily of numerical comparisons as to growth and influence, and counting the advertisements in the first issue of every third year, we find that the 63 business announcements in the Ja nuary number of 1883 have more than doubled (134) three years later, and almost quadrupled (234) in another three years; in 1892 the number is increased to 316, and the first issue of the present year contained 320 advertisements, the slight increase in the later years being due to the many consolidations of electrical firms and the cessation of promotion schemes. These figures, however, do not tell the entire story, and we add a comparative statement in order to illustrate the advance of The Electrical World as compared with the other electrical journals, choosing for this purpose its three principal weekly contemporaries, which are denoted in the order of their age by the letters A, B and C. The issues selected for comparison are those prepared for the National Electric Light Convention of this year, such special numbers being accepted as proper ones for comparison on account of expressing, by the volume of advertising contained, the opinion of business men as to the relative standing of the different journals. The advertising in inches was as follows:

The Electrical World.	A.	B.	C.
3,192	1,067	1,736	1,260

Why the Electrical World is Sometimes a Day Late.

READING MATTER. The growth in reading matter is scarcely a fair basis of comparison, for here quality and not quantity is the criterion. To quote from a recent article: "Were The Electrical World to depend for its contributors upon even the entire number of writers who occupied the electrical field as short a time as six or seven years ago, and maintain the present standard, its pages would probably shrink to half their number." While the quality of its contents has, therefore, undergone an immense change

for the better, the quantity since 1883 has also notably increased. During 1883 and 1884 the reading matter was confined to eight pages. At the beginning of 1884 the journal was embellished with a cover, and in its New Year announcement referred with pride to the increase in the number of its pages to 20, including advertising, apparently not dreaming of the 52 pages as a minimum which it was to attain before the end of the decade. In 1885 we find ten reading pages. Two more are added the next year, and, until 1889, this number sufficed except on extraordinary occasions. In the latter year the number was increased to 16, and in 1893, the last year of the old form, it averaged but little less than 20.

The Main Editorial Room.

CHANGE IN SIZE. Beginning with the first issue of 1894, The Electrical World appeared in its present form, which is the size of its predecessor, The Operator. The increase in the page made in 1883 when the paper became more technical, was necessary at that time to illustrate clearly to the reader, in the then state of the engravers' art, the new electrical systems and devices that had each week to be described. The advance in engraving —particularly by the wax process—enables details now to be shown just as clearly in a very considerably smaller space, and so for the convenience of the reader, though at considerable extra expense to the paper, the original size was returned to after eleven years. That the change has met with enthusiastic appreciation we have evidence, not only in the numerous expressions of opinions we have received on the subject, which have been of the most flattering character, but also in the increase of subscribers, which has varied from 7 per cent. to 34 per cent. compared with corresponding months of 1893.

WHAT IT COSTS. Has it ever occurred to the reader how much it costs to deliver to him a copy of The Electrical World? As the figures may be of interest we give below a table of items prepared last May to show the cost of each copy of the paper *after the forms are on the press*, both in the old and the new size.

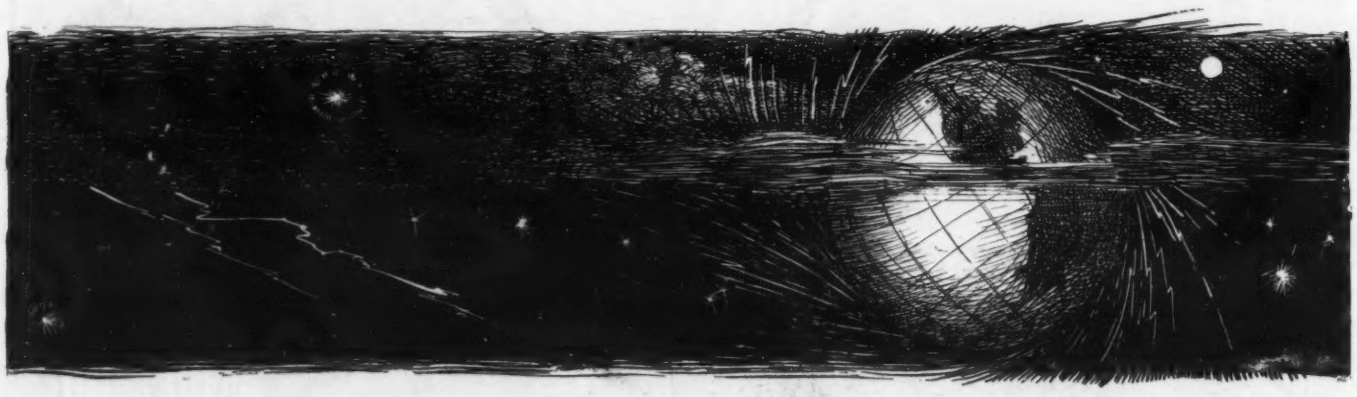
FIRST ISSUE OF	Paper		Press-Work		Postage, Fold'g, &c		TOTAL	
	1893	1894	1893	1894	1893	1894	1893	1894
JANUARY.....	3 3/10 cts.	4 cts.	1 1/10 cts.	1 8/10 cts.	1 8/10 cts.	1 8/10 cts.	5 8/10 cts.	7 8/10 cts.
FEBRUARY....	3 3/10 "	3 8/10 "	1 1/10 "	1 8/10 "	1 2/10 "	1 8/10 "	5 1/10 "	6 8/10 "
MARCH.....	4 "	4 8/10 "	1 1/10 "	2 2/10 "	1 4/10 "	2 1/10 "	6 4/10 "	9 1/10 "
APRIL.....	2 8/10 "	3 8/10 "	1 "	1 1/10 "	1 "	1 8/10 "	4 8/10 "	6 1/10 "
MAY.....	3 1/10 "	4 1/10 "	1 2/10 "	1 1/10 "	1 "	1 8/10 "	5 3/10 "	7 1/10 "
Average Cost.	3 1/10 cts.	4 cts.	1 1/10 cts.	1 8/10 cts.	1 1/10 cts.	1 8/10 cts.	5 7/10 cts.	7 8/10 cts.
Percentage of Increase		21 7/10%		50%		50%		33 7/10%

The above prices, considerable as they are, do not, it must be remembered, include typesetting, general editorial expenses, the cost of correspondence, of contributed articles or of illustrations; none of the expenses of the business department are included, nor rent, salaries, maintenance of branch offices, etc. With these added the cost of the paper reaches a figure which is fully double the price paid by the subscriber. The value of a journal to the advertiser however, lies entirely in its circulation and influence, and both of these depend upon the merit of its reading columns. As a consequence The Electrical World never ceases its efforts to enhance the character and usefulness of its contents, nor does it slacken its search for new subscribers.

AS THE PAST, SO THE FUTURE. Some have been good enough to say complimentary things regarding The Electrical World. With becoming modesty, however, it leaves others to determine the measure of its success, and in how far its efforts have borne fruit. Success in every line is achieved much in the same way. The same elements enter into it and the same principles underlie it. In the main it is simply the result of intelligent and persistent hard work. The Electrical World makes no claim other than for conscientious, unceasing effort, sometimes vigorously but always conservatively directed. While it has ever been the policy of the paper to look forward, not backward, it has never indulged in too fanciful visions of the future, believing that its first duty is with the present, or, as Carlyle has so happily put it, "Not to see what lies dimly at a distance, but to do what lies clearly at hand." Above all, The Electrical World has never rested on its laurels, but, taking advantage of the accumulated experience of the past, has steadily pushed forward, in the belief that the future would take care of itself. The Electrical World, having attained its majority, it is not unreasonable to suppose that the man will not depart from the paths in which the child was trained. There is no surer index of the future than the past.

"The future does not come from before to meet us, but comes streaming up from behind over our heads.

RAHEL.



"Hath electric power which earth can never tame; lightning may scowl and dark clouds lower—its flash is still the same."

—LYDIA MARIA CHILD.